NASA LEWIS FINAL TECHNICAL REPORT

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PREDICTION OF SOUND RADIATION FROM DIFFERENT PRACTICAL JET ENGINE INLETS

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ATLANTA, GEORGIA 30332

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ABSTRACT

This report summarizes the work performed under NASA Lewis Grant Number NAG 3-67 entitled, "Prediction of Sound Radiation from Different Practical Jet Engine Inlets" during the two year period from June 2, 1980 to July 31, 1982. The objectives of this study included the following: (1) upgrade existing computer codes which were based upon a special integral representation of the external solutions of the Helmholtz equation, so that they would yield accurate results for the acoustic radiation patterns in the field surrounding an axisymmetric body for non-dimensional wave numbers, based on duct radius, of up to twenty; (2) check the accuracy of these computer programs by the use of the point source method for the generation of "exact" solutions and then by comparison with the results of other experimental and theoretical studies; and, (3) use these computer codes in a parametric study of the dependence of the radiated sound field on input modal distribution, wave number, and inlet lip shape. The results of this study show that: (1) as the wave number (i.e., cut-off ratio) is increased for a given input modal distribution that the acoustic radiation peak moves towards the inlet centerline and becomes more compact (i.e., narrows); (2) as the input mode number is increased for a given cut-off ratio the acoustic radiation peak moves away from the inlet centerline and becomes more compact; and, (3) as the inlet lip becomes thicker the acoustic radiation peak moves towards the centerline of the inlet and becomes more compact.

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I. INTRODUCTION

This report summarizes the work performed under NASA Lewis Contract Number NAG 3-67 during the period June 2, 1980 to July 31, 1982. This research program was concerned with the determination of the radiation patterns around different practical jet engine inlet configurations when subjected to different excitation conditions. This was accomplished in two phases, with the first phase completed during the first year of this contract and the second phase the following year.

During the first year of this project the computer codes required for this investigation were developed. The initial task of this first phase was the upgrading of existing computer codes for the calculation of both the surface and field distributions of the acoustic quantities of interest (i.e., the acoustic potential and acoustic velocity normal to the wall). The theoretical basis for these programs is presented in Refs. 1-3. These references track the development of a unique integral formulation of the acoustic radiation problem and its application in the calculation of two dimensional, three dimensional and cylindrically symmetric radiation patterns. The cylindrically symmetric formulation of Ref. 3 (See Appendix A of Ref. 4.) was used in this investigation as all of the inlet geometries investigated were axisymmetric. The details of the upgrading of the computer codes is presented in Ref. 4. This initial computer code development work was accomplished using the NASA Lewis QCSEE inlet configuration of Ref. 5 and was checked against "exact" solutions generated by the point source method as described in Ref. 3.

The second task completed during the first year was the consolidation of the two main computer programs, along with the many smaller computer programs developed to do such things as calculate the cut-off wave numbers for various modes, the generation of input modal distributions and the geometrical shapes of the bodies of interest, and the data plotting routines into a coherent package of programs. This program package was then used to investigate the acoustic behavior of five different inlet configurations; namely: the NASA Langley Bellmouth[6,7]; the NASA Lewis JT15D-1 Ground Test Nacelle[8,9]; and three hyperbolic inlets of 50, 70 and 90 degree divergence angles, similar to those investigated by Y. C. Cho[10,11]. Although the main objective of this study was to compare the radiation patterns generated by the integral technique[1-3] with those calculated/measured in other theoretical/experimental studies, reflection coefficients were also calculated at the duct exit plane for certain specific inlet configurations where these results were available. The results of these studies are presented in Ref. 12.

During the first half of the second contract year a series of 35 computer runs were performed for the NASA Langley Bellmouth inlet configuration[6,7]. These 35 computer runs provide a parametric study of the dependence of the sound radiated from this inlet geometry upon the specified input modal distributions and the cut-off ratios given in Table I. For each of these runs, both the distribution of the reflection coefficient at the duct exit plane and the distribution of the SPL (Sound Pressure Level) in the field were calculated. These results were cross plotted holding the input

modal distribution or the cut-off ratio constant and can be found in Ref. 13.

During the final half year of this two year contract the computer programs were updated to run on the new computer systems here at Georgia Tech as the old CDC Cyber 70/74 system was replaced by two new CDC Cyber computers; a 730 and a 760. Also, with the new campus network in operation, printouts could be obtained on site rather than only at the computer center which greatly reduced printing costs. This network also allowed the down loading of data files from the CDC computers to the Hewlett-Packard 2100 series mini-computer in the School of Aerospace Engineering for plotting. Having accomplished this, the computer program which uses the calculated surface distributions on the body to calculate the radiated sound field outside the body was modified at the sponsor's request to: (1) calculate the acoustic radiation pattern all around the body from 0 to 180 degrees from the inlet centerline at one degree increments instead of from 0 to 90 degrees in two degree increments; and, (2) to calculate the radial distributions of the reflection coefficients across the inlet at five axial stations from the striaght duct exit plane to the inlet exit plane. This updated field code was then re-run for the 35 cases done previously for the NASA Langley Bellmouth inlet configuration. The field data was then plotted and cross plotted as before (See Ref. 13.) holding either the input modal distribution or the cut-off ratio constant. The distributions of the reflection coefficients at the five axial stations were also plotted for the five cases run for each of the two input modal distributions (i.e., (M, N) = (4,1) and (4,3)).

Two elliptical inlet geometries were supplied by the sponsor for study and they will be designated here as the "thin" and "thick" lipped elliptical inlets. Thirty five computer runs were done for each of these inlet configurations at the same input conditions as was done for the NASA Langley Bellmouth inlet configuration (See Table I.). The same plots and cross plots were obtained for each of these geometries and the results are presented herein. In addition, the radiation patterns generated by all 105 computer runs were cross plotted varying the inlet geometry while holding the input modai distributions and the cut-off ratios constant. These plots are also presented in this report.

II. THE LANGLEY BELLMOUTH INLET

Figures 1-3 represent the distributions of the calculational points on the surface of the theoretical model used to simulate the NASA Langley Bellmouth inlet for the various computer runs. The open circles are the points where the acoustic quantities are calculated while the locations denoted by the small crosses are those used in the integration procedure. The arrows represent the outward normals from the body at the various points on the body as these plots offer a visual check of the geometric input data for the computer programs. One should note that the driver plane also represents the duct exit plane as there is no straight duct section connected to the inlet lip. This was done to conserve computer space, which was limited in the old Cyber computers, and computing time, which goes up roughly as the square of the number of points used on the surface of the body, as the effect of a straight duct connected to the inlet lip was not investigated in this study. Finally, it should be noted that the theoretical geometry is terminated in all cases by a 2:1 ellipse as the Helmholtz equation is elliptic and is therefore only applicable to closed bodies.

Descriptions of the computer runs conducted for each of the three geometries investigated are presented in Table II. Since the required computer runs for this parametric study cover a wide range of input modes and cut-off ratios (i.e., wave numbers), the number of calculational points on the body was not the same for all of the runs. This is due to the fact that as the wave number (cut-off ratio) is increased more points must be used on the body in the longitudnal direction to adequately discribe the distributions of

the acoustic quantities on the surface of the body. Also, as the input mode number is increased, the number of points in the tangential direction must be increased for the same reason.

In Figs. 4 and 5 the modulus and phase of the radial distributions of the reflection coefficients are presented at five axial locations along the inlet starting at the duct exit plane, (i.e., the driver plane), station 1, and ending at the inlet exit plane, station 5. These stations are separated by equal axial distances so that station 3 is located at the middle of the inlet lip. The non-dimensional axial distances of these stations from the driver plane are given in Table III where the reference distance is the radius at the driver plane. Figures 4 and 5 present the results for the input modes of (M,N) = (4,1) and (M, N) = (4,3), respectively. These plots show that as the acoustic wave moves out of the inlet the modulus of the reflection coefficient steadily decreases as does the phase. Also, as the wave number (cut-off ratio) goes up the modulus of the reflection coefficient decreases while its phase increases.

The radiation patterns for the 35 cases run for the Langley Bellmouth are presented in Ref. 13 (See Figs. 4-38.) and therefore will not be repeated here. When these data are displayed on separate plots the results are not easy to compare and therefore trends are not obvious. To alleviate this problem, these data are compared in plots of the relative SPL (Sound Pressure Level) in decibels and the phase in degrees versus the angular location in Figs. 6-10. Each of these plots describes SPL levels referenced to the point in the field where the maximum SPL occurs for each case. Each figure contains the SPL in dB plotted in two different ways so that trends

can easily be detected. For example, the same data are plotted in Figs. 6a & c and 6b & d where in Figs. 6a & b the curve are all referenced to the same SPL level (i.e., zero) in Figs. 6c & d each curve is referenced to a different SPL level. The actual data was calculated at one degree increments on a circle centered at the inlet exit plane with a radius of 20.33 driver radii. Each figure contains all of the results for the various cases run for each input mode (i.e., Fig. 6 contains the results for an input mode of (M,N) = (1,1), etc..). One should note that there is a change of scale in Figs. 6a & b and in Figs. 7a & b and that some of the cases are repeated for clarity as is done in Figs. 6c & d, 6e & f, 7c & d, and 7e & f. One should also note that since the theoretical geometry outside and behind the inlet lip does not model the true geometry of the actual inlet, the results in the field past 90 degrees from the centerline are suspect and at best only provide the qualitative trends of the sound distribution in these locations.

In Figs. 11-16 the relative SPL and phase distributions of the sound fields associated with the Langley Bellmouth are presented. Specifically, these figures describe cases where the cut-off ratio is held constant and the input modal distribution is varied. As in the previous set of figures, the relative SPL is plotted in two different ways in each figure for clarity.

III. THE THIN LIPPED ELLIPTICAL INLET

The model geometries used for the 35 cases run for the thin lipped elliptical inlet are given in Figs. 17-19. As with the Langley Bellmouth inlet, three different numerical approximations were employed for various input conditions. The runs for which each approximation was used are presented in Table II. One should note that the nominal point spacings on this inlet are half of those used on the Langley Bellmouth thereby making the calculations more accurate. This was done for the following reasons: (1) with the new computers more points could be taken on the surface of the body as more computational space was available; and, (2) since the inlet lip is considerably smaller, a closer point spacing was necessary to adequately describe the relatively faster changing curves. This inlet lip consists of a 2:1 ellipse whose semi-major axis is 0.2 of the non-dimensional driver radius, a. It is capped with a semi-circle of radius 0.025a and has a 2:1 ellipse as its outer wall and is terminated by yet another 2:1 ellipse.

In Figs. 20-24 the SPL in dB are plotted and tabulated from 0 to 90 degrees in two degree increments. Each figure contains all of the plots for the cases run for each modal input (e.g., Fig. 20 consists of the 9 plots, one for each cut-off ratio, for an input mode of (M,N) = (1,1), etc..). These data represent actual values generated in each case and not just the relative values. Also, when comparing these plots, care must be exercized as all of the plots do not use the same limits.

The modulus and phase of the radial distributions of the reflection coefficients are presented in Figs. 25 and 26 for input modal distributions of

(M,N) = (4,1) and (4,3), respectively. The results for this inlet configuration show that the reflection coefficients don't follow the same trends over the entire spectrum of investigated wave numbers for both input modal distributions. For example, the modulus of the reflection coefficient decreases as the wave moves down the inlet in Figs. 25a,c,e and g. while it increases in Figs. 25 i and k.

In Figs. 27-31 the relative SPL in dB and phase in degrees are plotted. Each figure represents all of the cases run for the thin lipped elliptical inlet for a given input modal distribution. As before, the relative SPL is plotted in two ways in each figure for the sake of clarity. Also, as before, some of the curves are replotted for certain cases (e.g., see Fig. 27a & b) for ease of comparison and because the scales change between these plots. It is of interest to note that although the lobe which contains the maximum SPL changes for the Langley Bellmouth inlet (See Fig. 10a & b.) when the (M,N) = (4,4) mode is cut-on (See Table I.), this does not happen for the thin lipped elliptical inlet. While in the Langley Bellmouth inlet the maximum SPL moves from the first lobe (closest to the centerline) to the third lobe as the wave number increases, the maximum SPL always remains in the third lobe for the thin lipped elliptical inlet.

The radiation patterns are re-plotted in Figs. 32-37 holding the cut-off ratio constant and varying the input mode. Again, the relative SPL is plotted in two different ways in each figure so that trends are more easily discernable.

IV. THE THICK LIPPED ELLIPTICAL INLET

Figures 38-40 contain the model of representations used for the thick lipped elliptical inlet geometry. As with the other two inlet geometries, these three different numerical descriptions of the model of the geometry are used for certain of the 35 computer runs done for this geometry (See Table II.). The inlet lip is simply twice as large as the thin lipped inlet geometry so that it too is described by a 2:1 ellipse whose semi-major axis is 0.4a instead of 0.2a. It is also capped with a semi-circle (of radius 0.05a) and terminated by a 2:1 ellipse.

The SPL in dB is both poltted and tabulated for the 35 cases run for this geometry (See Table I.) in Figs. 41-45. As before, each figure contains the plots for all of the cases run for a particular input mode. One should note again that these plots are of the actual SPL values calculated in the programs and that the scales on all of the plots are not the same.

In Figs. 46 and 47 the modulus and phase of the radial distributions of the reflection coefficients at five stations down the inlet are presented. Each figure contains the plots of all of the cases run for a particular mode. As with the thin lipped elliptical inlets results, these distributions do not follow consistent trends as the wave number is increased or as the waves move down the inlet. The axial locations of the different stations are given in Table III.

The relative SPL in dB and phase in degrees of the acoustic radiation patterns outside the inlet are plotted in Figs. 48-52. As before, each figure

represents all of the cases run for a given mode for the thick lipped elliptical inlet. Also, the relative SPL is plotted in two ways in each figure and in Figs. 48 and 49 some of the curves are duplicated in separate plots for ease of comparison.

In Figs. 53-58 the radiation patterns are re-plotted holding the cut-off ratio constant in each case rather than the input mode. Each figure consists of three plots; two of the relative SPL in dB and one of the phase in degrees. The data for these plots were generated at one degree increments and the plots were obtained by having the computer draw straight lines between these data points. This accounts for the sharp corners observed on some of the curves (See Fig. 58a.) and the gaps in the curves when they cross 180 degrees (See Fig. 58c.).

V. THE EFFECT OF INLET LIP CURVATURE ON ACOUSTIC RADIATION PATTERNS

The principle goal of this parametric study was to show the effect of inlet lip curvature on the acoustic radiation patterns generated by the same acoustic excitation. In the course of this study 35 computer runs were made for each of the three inlet geometries; the Langley Bellmouth, the thin lipped elliptical inlet, and the thick lipped elliptical inlet; for the same input model distributions (See Table I.). Since the duct exit/driver plane was non-dimensionalized to one for each geometry the acoustic excitation applied in the computer program was the same for each geometry. This does not mean, however, that the same acoustic power was supplied in each case as this is an elliptic problem and conditions at the driver plane depend upon the properties on the remaining boundaries. In these studies the acoustic potential (which is directly related to the acoustic pressure) was specified as the boundary condition at the driver plane while a zero normal acoustic velocity (i.e., a hard wall) was specified on the rest of the body. This means that in each case the normal acoustic velocity was calculated on the driver plane which, in turn, resulted in a different acoustic power out of the driver (and therefore the inlet) for each case.

Two options for normalization of the radiation patterns were therefore available: (1) normalize with respect to the peak radiated acoustic pressure; or, (2) normalize the curves with respect to the total radiated power (which for a hard walled geometry is equivalent to the power out of the driver). Since this study was more interested in the shape of the

acoustic radiation patterns, than in the total power radiated, the first normalization scheme was used. The second normalization scheme would entail the calculation of the PWL (Sound Power Level) in the field rather than the SPL (Sound Pressure Level) and than an integration under the curve for the normalization factor. It had previously been found by the authors of this report that in general the PWL and SPL curves are very simiiar[4] and almost interchangeable in the field surrounding the inlet. This being the case, the effect of the second type of normalization on the curves can easily be determined by inspection; that is, by doing a rough estimate of the area under the curves. One must be careful however as the area of the sphere must be taken into account so that the middle must be more heavily weighted than the ends.

The results of the 105 computer runs are presented in Figs. 59-63. Each figure contains all of the plots for each input mode, one plot for each cut-off ratio (wave number). An examination of these figures reveals two trends; which are: (1) as the inlet lip gets larger the maximum radiation peak moves further towards the centerline (in front of the inlet); and (2) as the inlet lip thickens, the maximum radiation peak becomes narrower and better defined. Both of these trends are consistent with the expectation that a larger inlet lip will better focus the radiated acoustic energy.

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TABLE I

Non-Dimensional Wave Numbers Used in Computer Runs

	(Tangential, Radial) Modes				
Cut-Off Ratios	(1,1)	(2,1)	(4,1)	(8,1)	(4,3)
1.005	1.850	3.069	5.345	9.695	12.74
1.015	1.869	3.100	5.398	9.792	12.87
1.064	1.959	3.249	5.658	10.26	13.49
1.155	2.127	3.527	6.142	11.14	14.65
1.305	2.403	3.985	6.940	12.59	16.55+
1.556	2.865	4.752	8.275	15.01*	19.73+‡
1.740		5.314			
2.040	3.756				
2.150		6.566			
2.500	4.603				
2.870	5.284				

* (8,2) Mode cut-on

\+ (4,4) Mode cut-on

‡ (4,5) Mode cut-on

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TABLE II

Number of Points Used in the Surface Integrations

Number of Points on the Body	Nominal Point Spacing on the Body	Range of Non-Dimensional Wave Numbers (ka)
	LANGLEY BELLMOUTH INLET	
102	0.04	0 --> 5
155	0.025	5 --> 12
189	0.02	12 --> 20
	THIN LIPPED ELLIPTICAL INLET	
97	0.02	0 --> 5
146	0.0125	5 --> 12
179	0.01	12 --> 20
	THICK LIPPED ELLIPTICAL INLET	
116	0.02	0 --> 5
176	0.0125	5 --> 12
216	0.01	12 --> 20

Number of Points in Tangential Integration	Range of Tangential Mode Numbers (M)
32	0 --> 3
64	4 --> 7
96	8 --> 11

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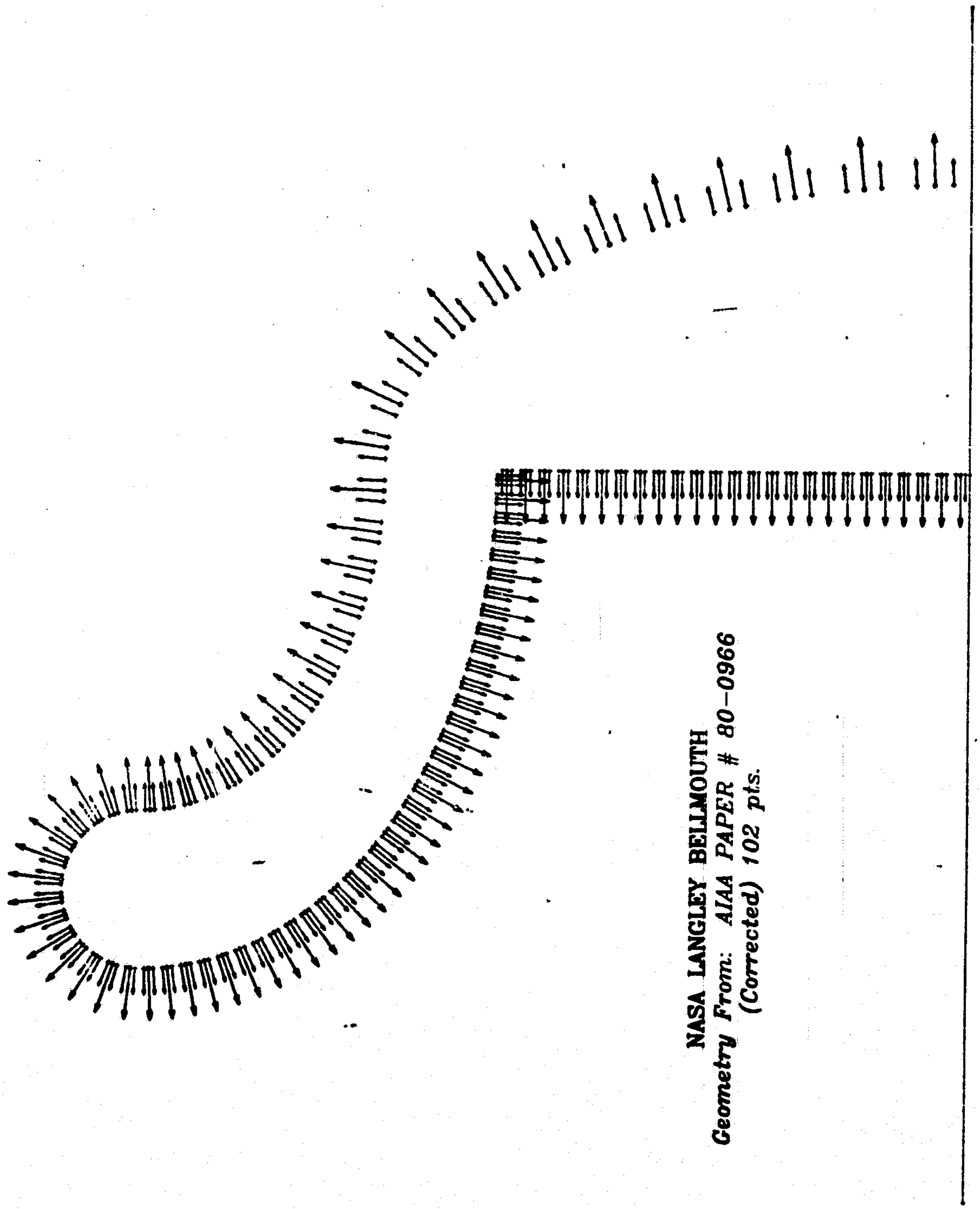
TABLE III

Axial Distances for the Calculation of the Radial Distributions of the Reflection Coefficients in the Inlets

Station Number	Langley Bellmouth Inlet	Thin Lipped Elliptical Inlet	Thick Lipped Elliptical Inlet
1	0.0	0.0	0.0
2	0.267	0.05	0.1
3	0.535	0.1	0.2
4	0.802	0.15	0.3
5	1.069	0.2	0.4



NASA LANGLEY BELLMOUTH
Geometry From: AIAA PAPER # 80-0966
(Corrected) 102 pts.

Fig. 1

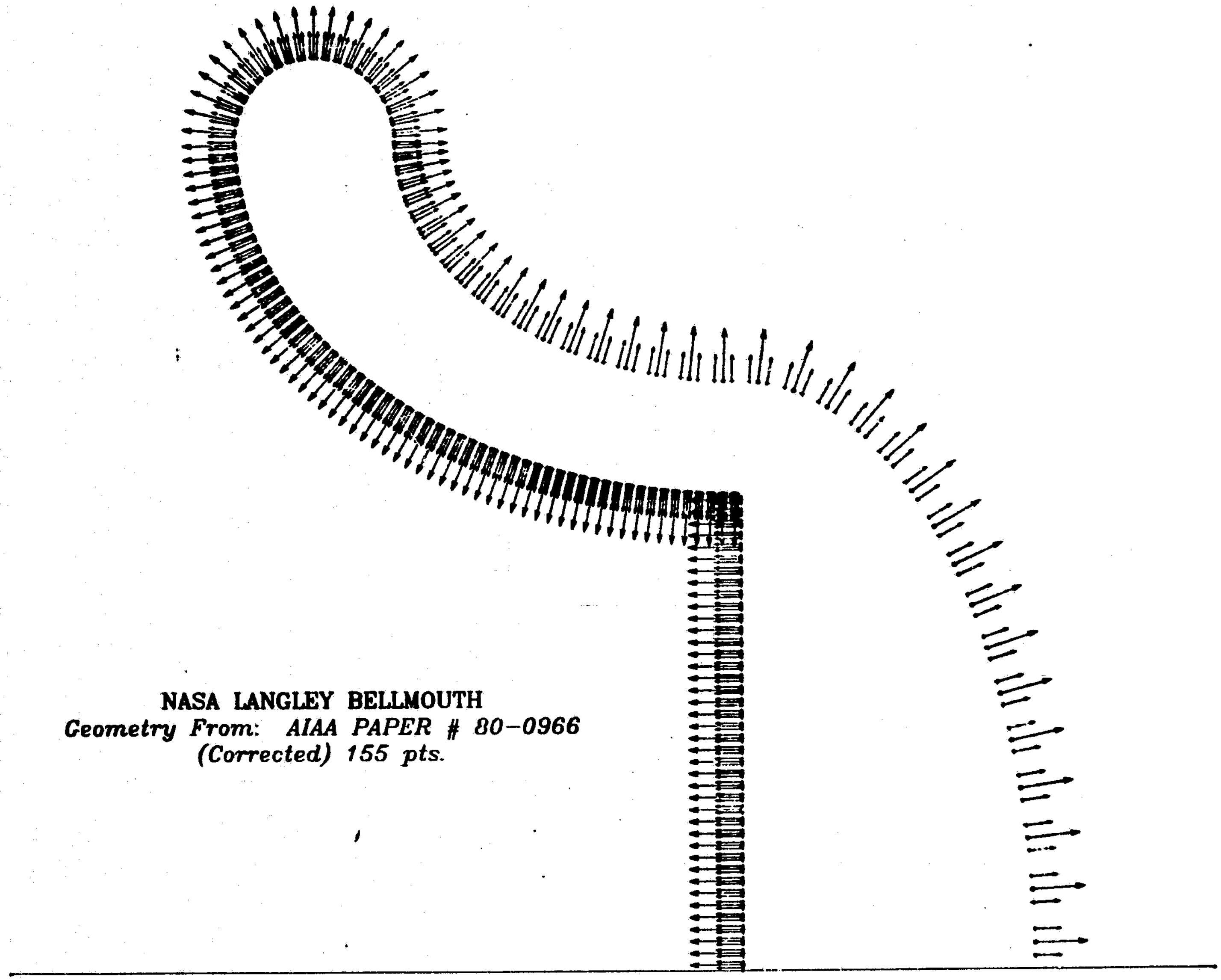
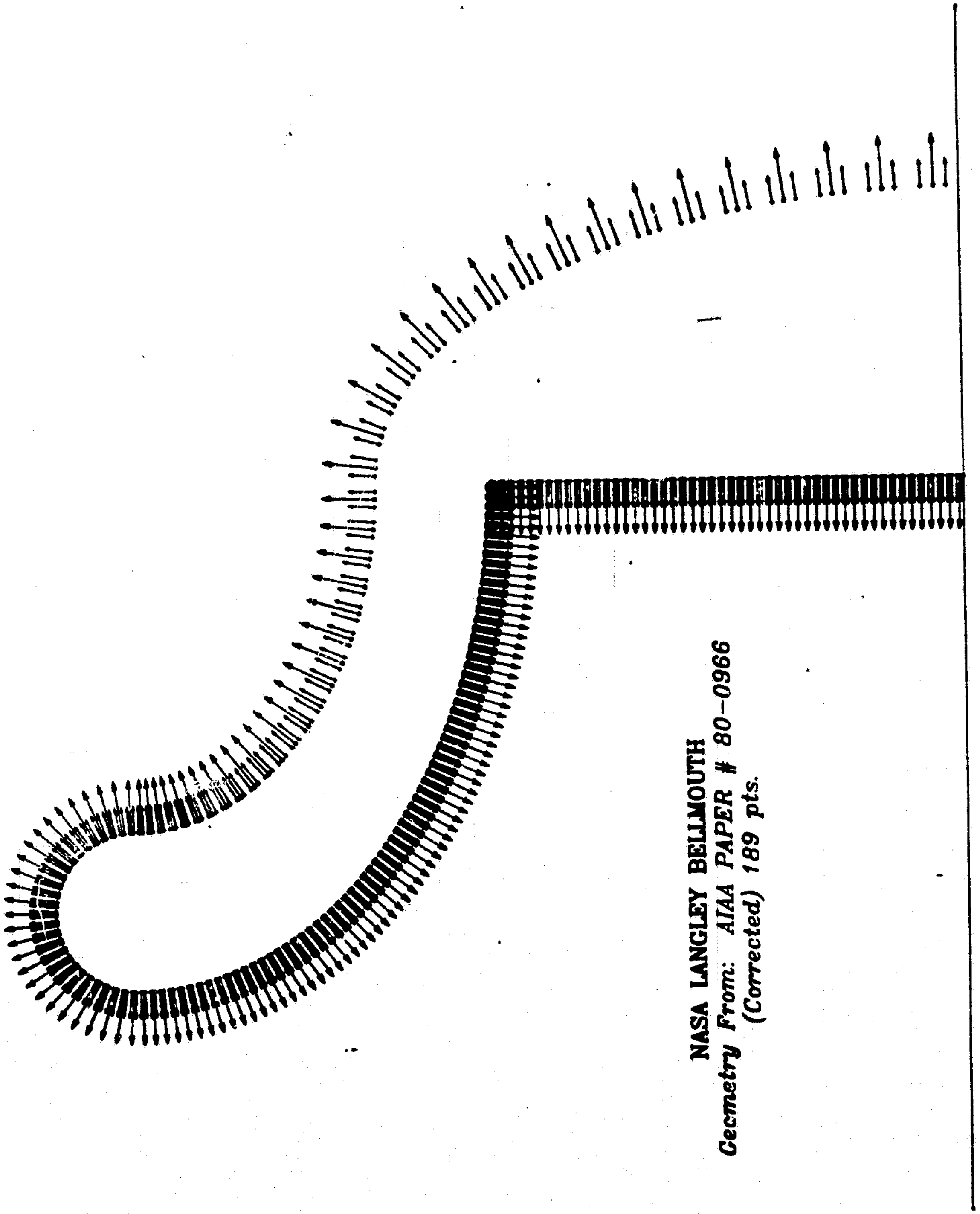
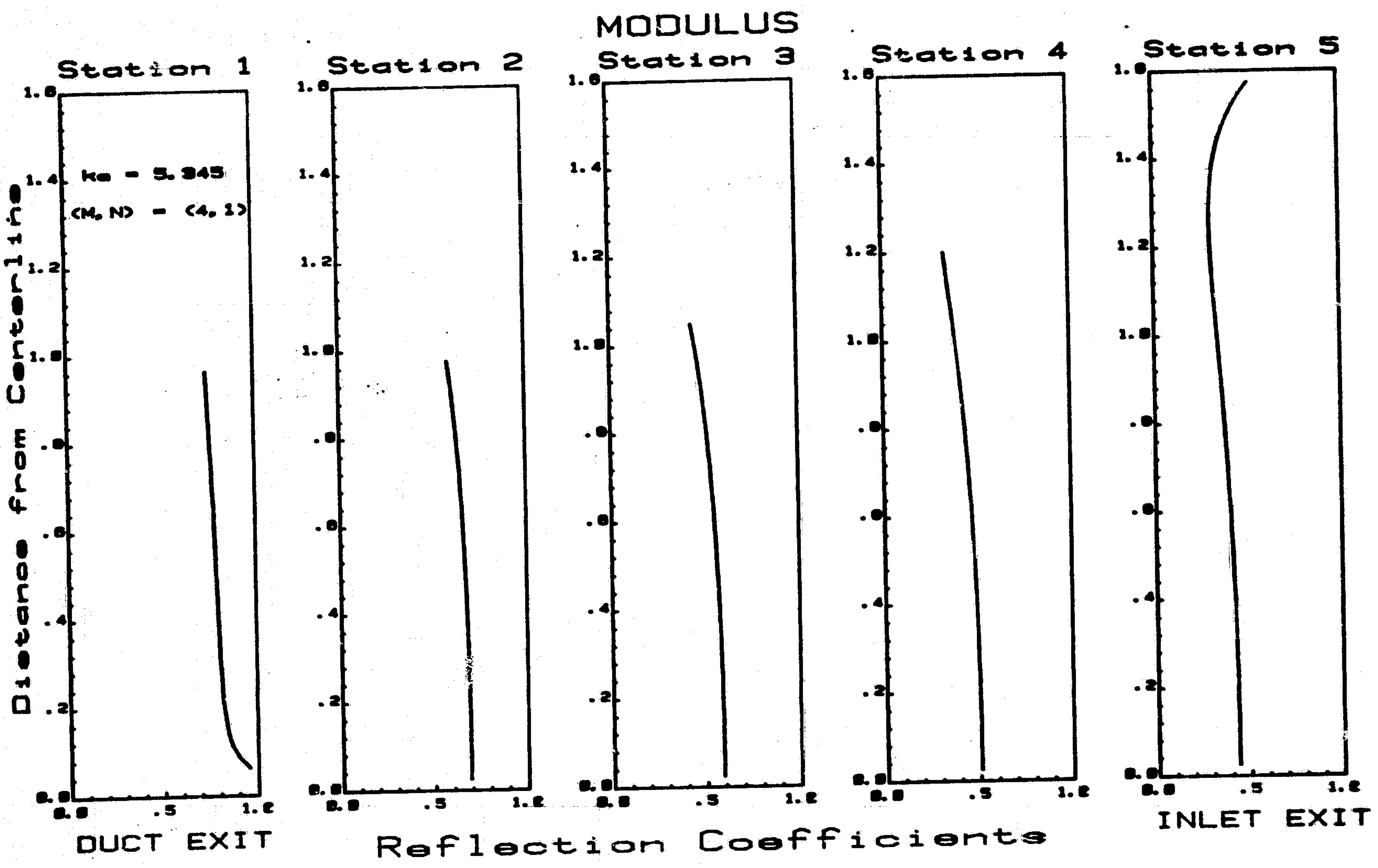

NASA LANGLEY BELLMOUTH
Geometry From: AIAA PAPER # 80-0966
(Corrected) 155 pts.

Fig. 2



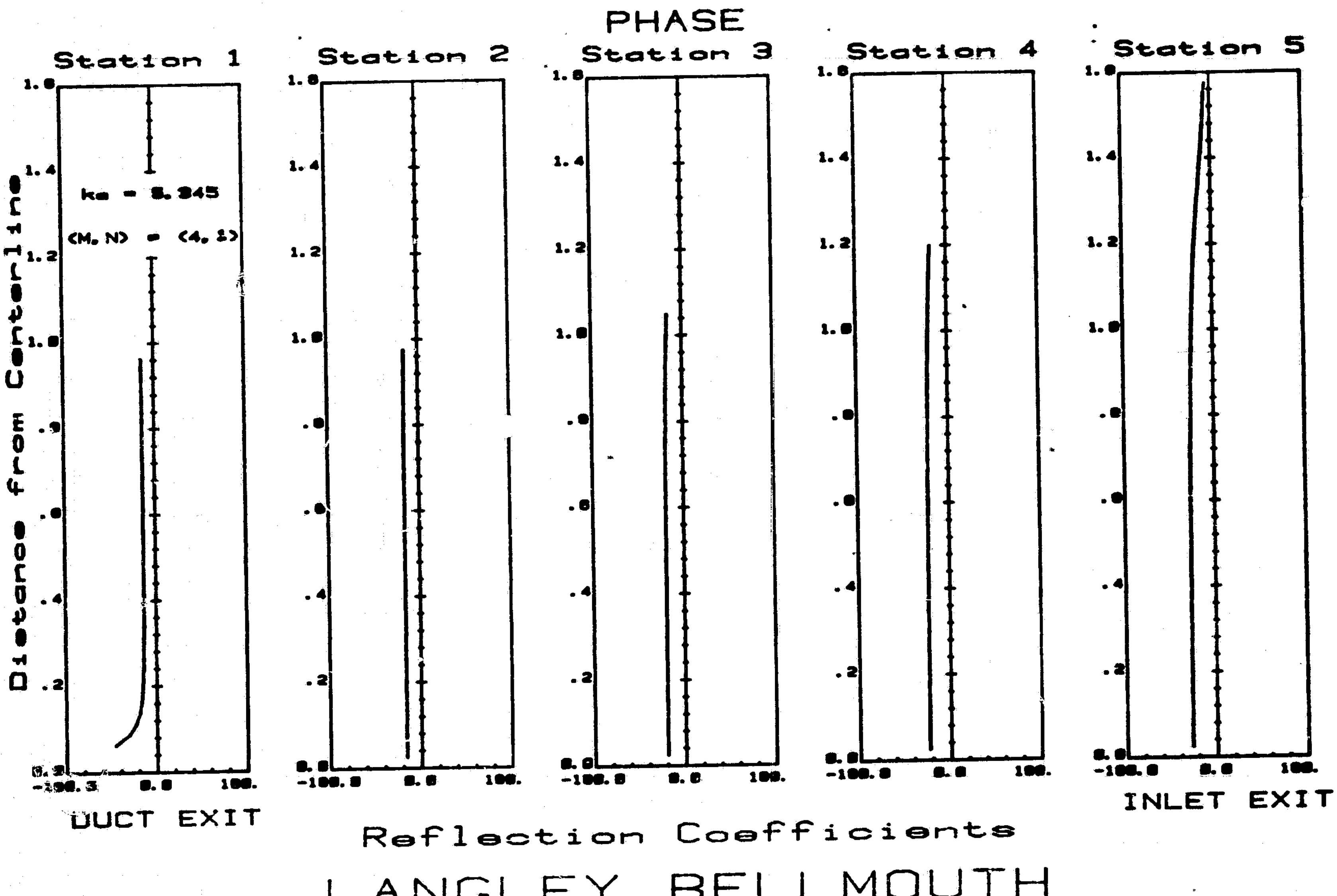
NASA LANGLEY BELLMOUTH
Geometry From: AIAA PAPER # 80-0966
(Corrected) 189 pts.

Fig. 3



LANGLEY BELLMOUTH

Fig. 4a



PHASE
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 8.345
(M, N) = (4, 1)
Distance from Centerline
1.6
1.4
1.2
1.0
.8
.6
.4
.2
0.0
-100.0
0.0
100.
DUCT EXIT
INLET EXIT
Reflection Coefficients
LANGLEY BELLMOUTH

Fig. 4b

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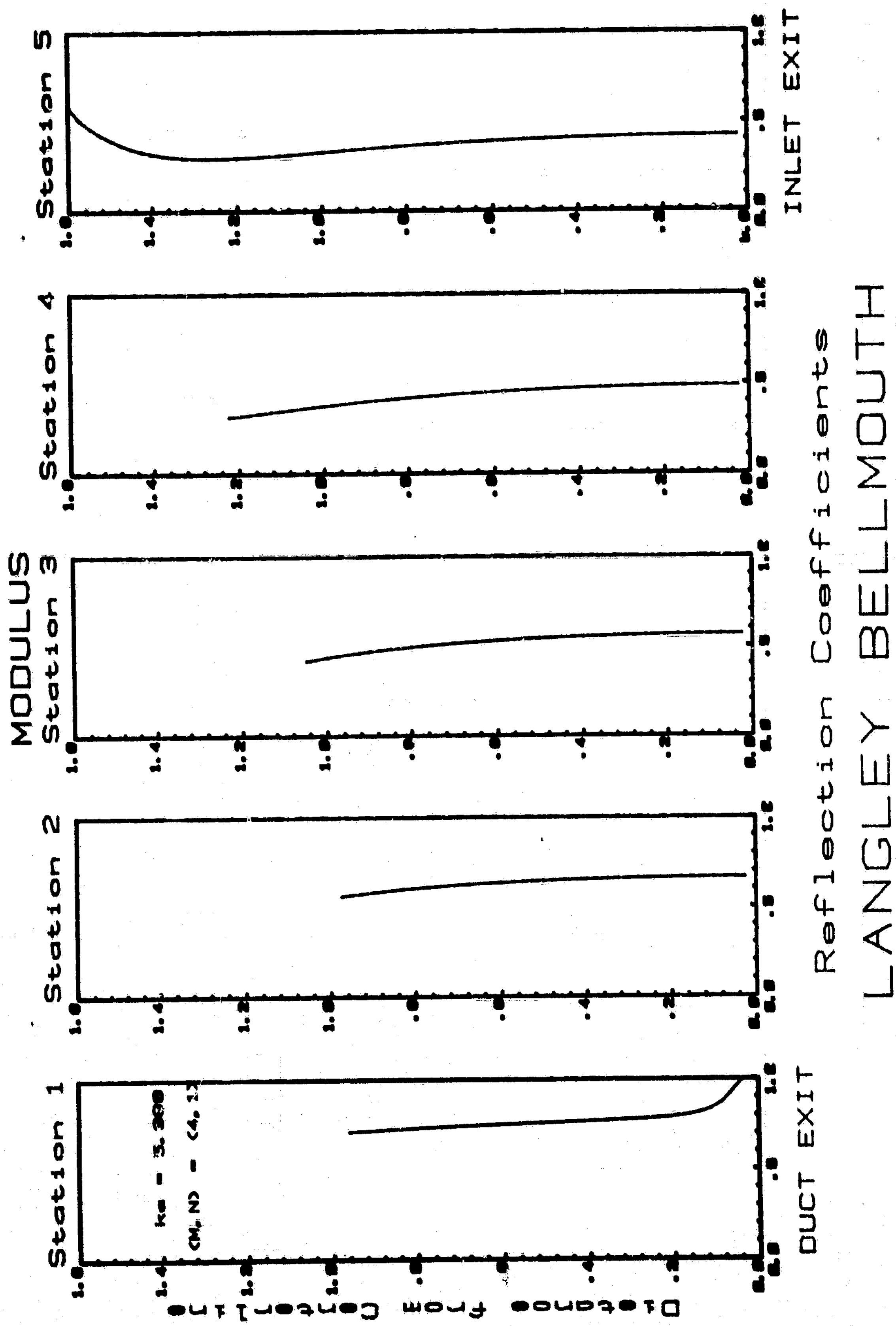

Fig. 4c

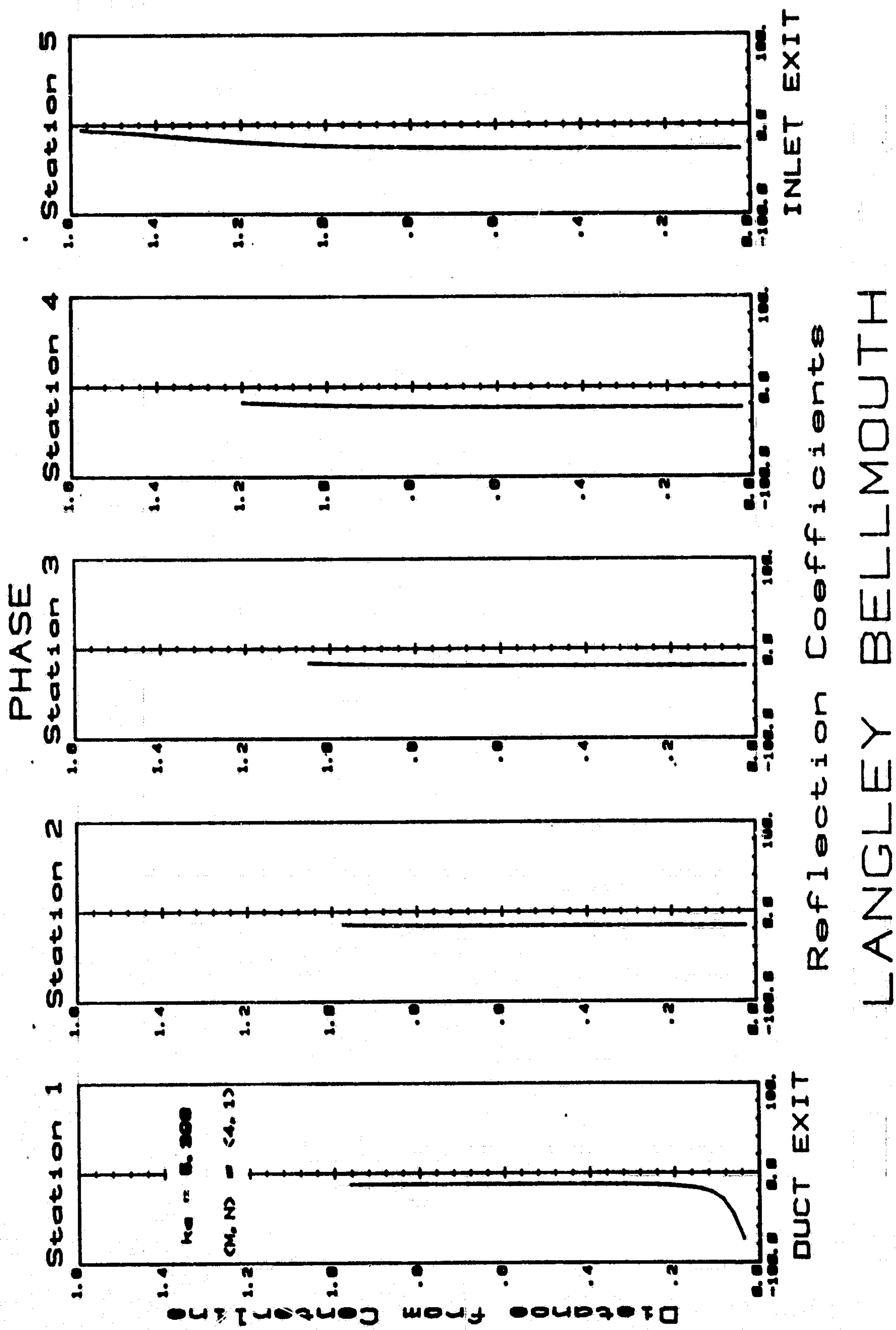
PHASE
Station 1
Station 2
Station 3
Station 4
Station 5
Reflection Coefficients
LANGLEY BELLMOUTH
DUCT EXIT
INLET EXIT
Distance From Centerline
(M, N) = (4, 1)
1.6
1.4
1.2
1.0
.8
.6
.4
.2
0.0
180.
0.0
-180.0

Fig. 4d

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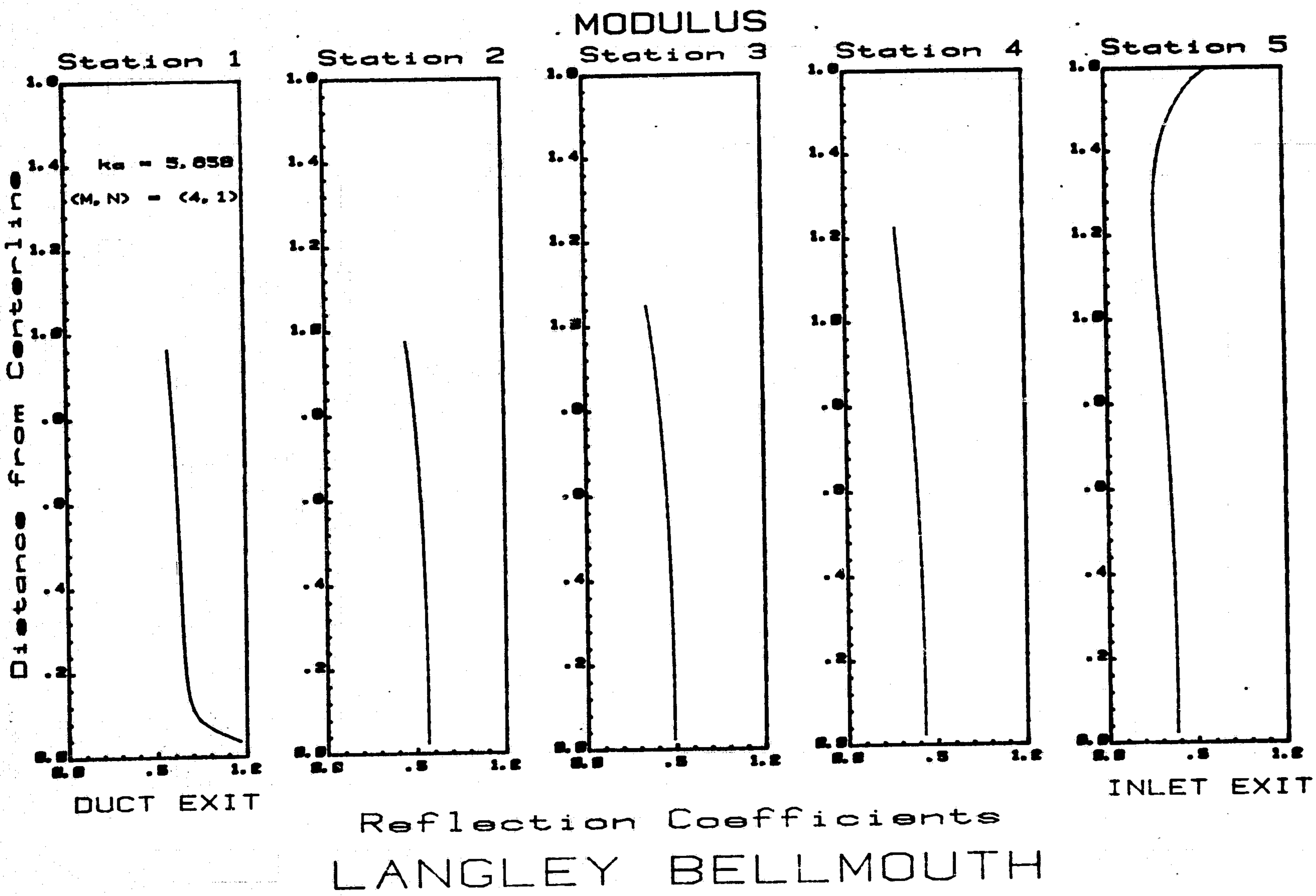


Fig. 4e

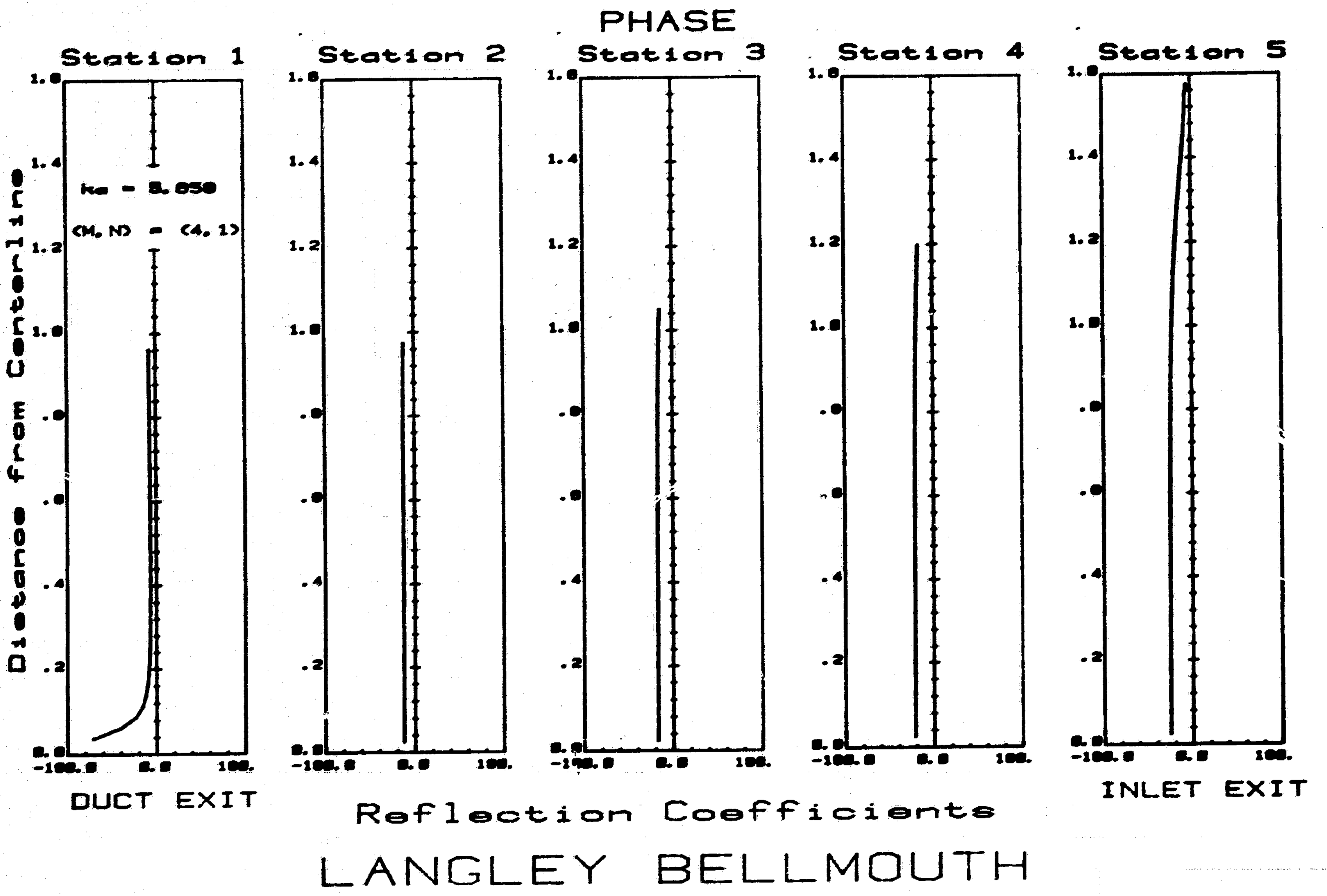

PHASE
Station 1
Station 2
Station 3
Station 4
Station 5
(M, N) = (4, 1)
Distance from Centerline
DUCT EXIT
INLET EXIT
Reflection Coefficients
LANGLEY BELLMOUTH

Fig. 4f

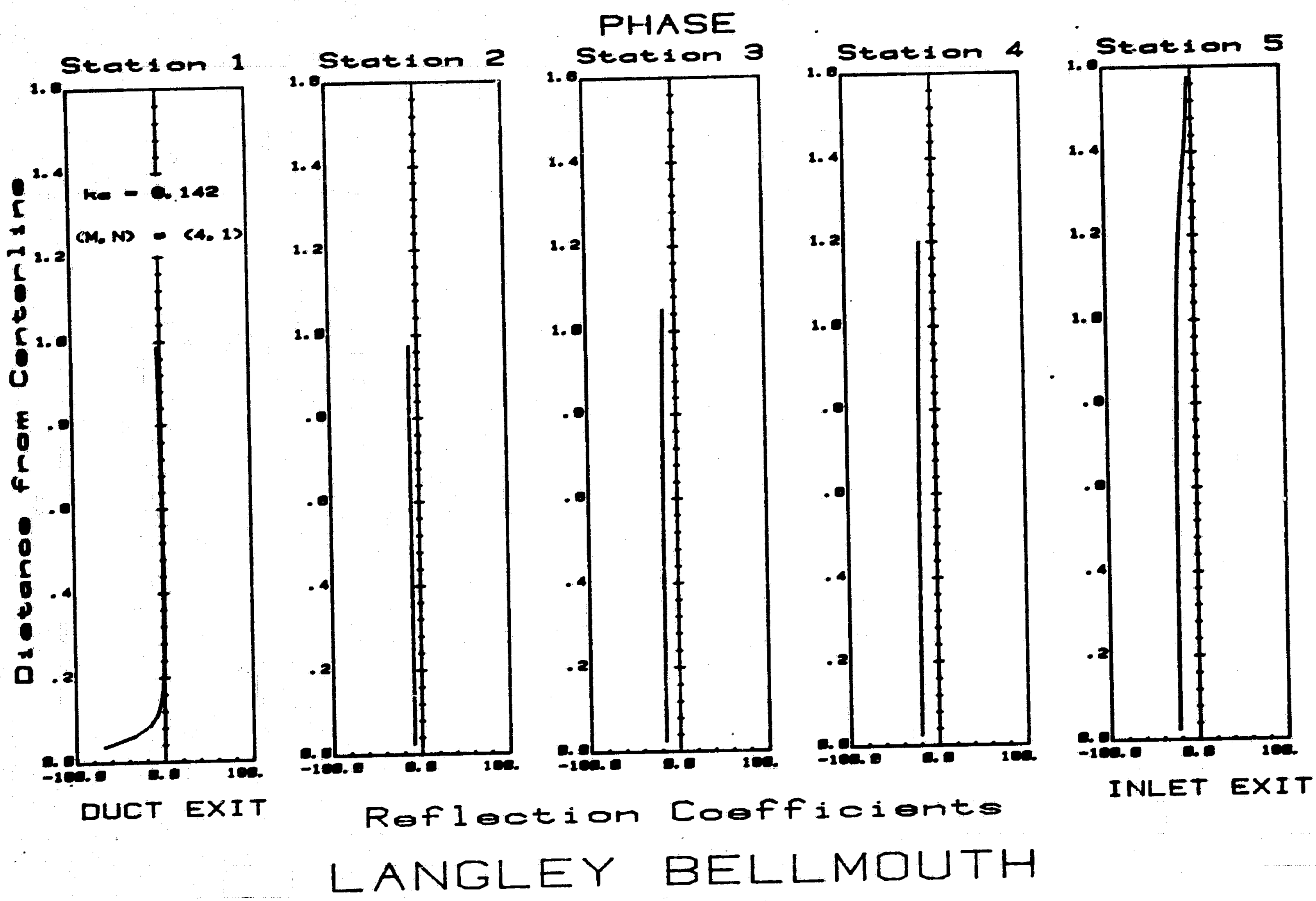
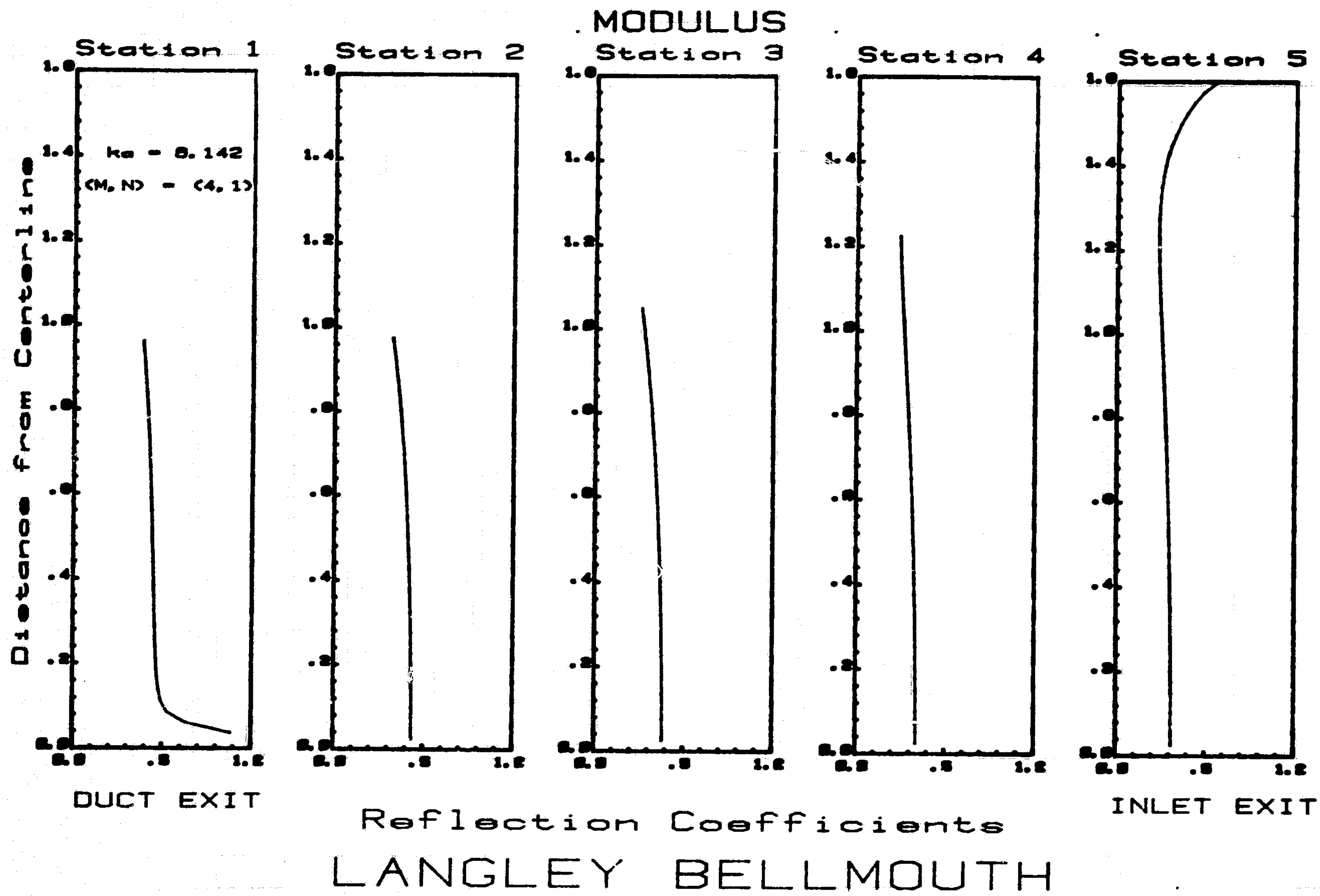

PHASE
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 0.142
(M, N) = (4, 1)
Distance from Centerline
1.6
1.4
1.2
1.0
.8
.6
.4
.2
0.0
-180.0
0.0
180.
DUCT EXIT
INLET EXIT
Reflection Coefficients
LANGLEY BELLMOUTH

Fig. 4g



MODULUS
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 8.142
(M, N) = (4, 1)
Distance from Centerline
DUCT EXIT
INLET EXIT
Reflection Coefficients
LANGLEY BELLMOUTH

Fig. 4h

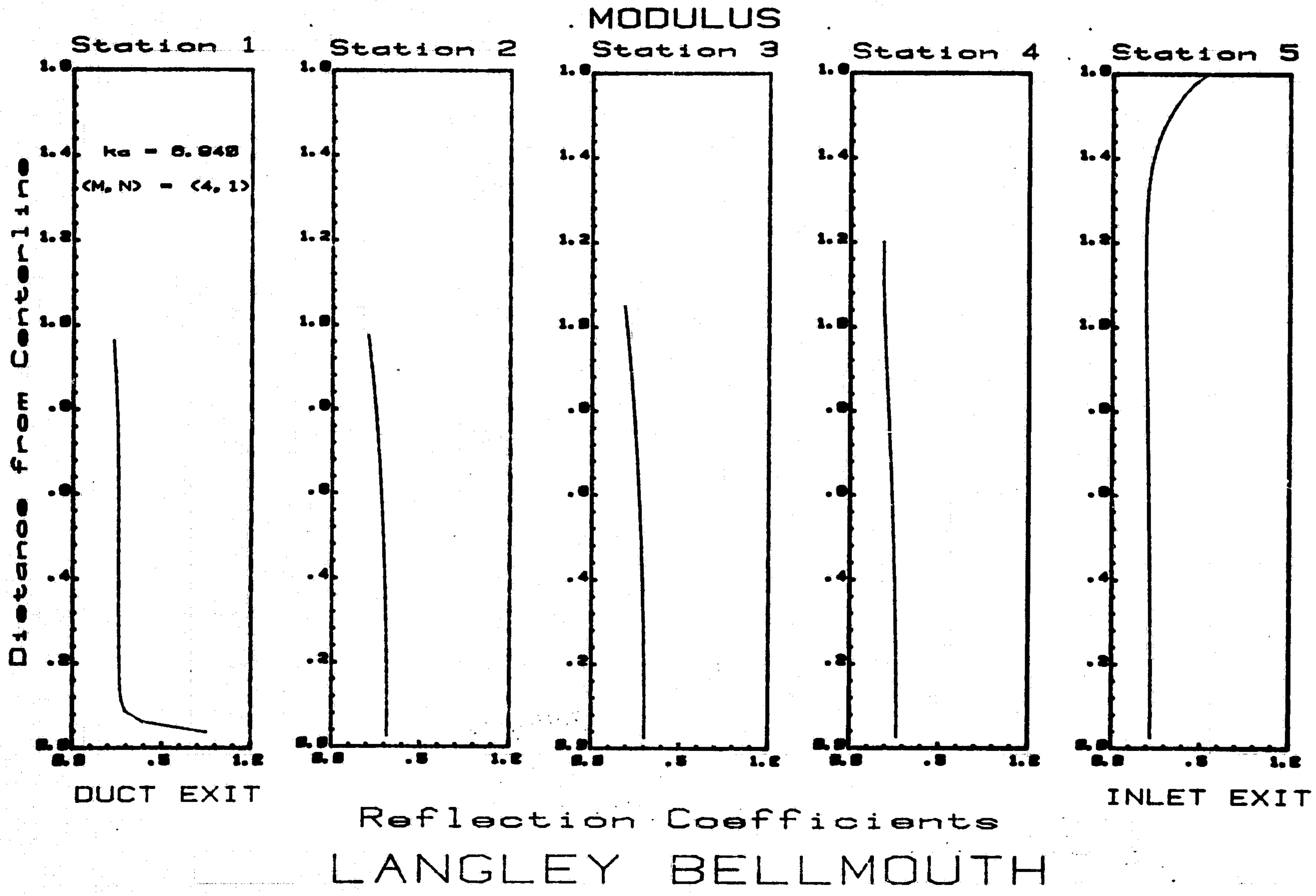
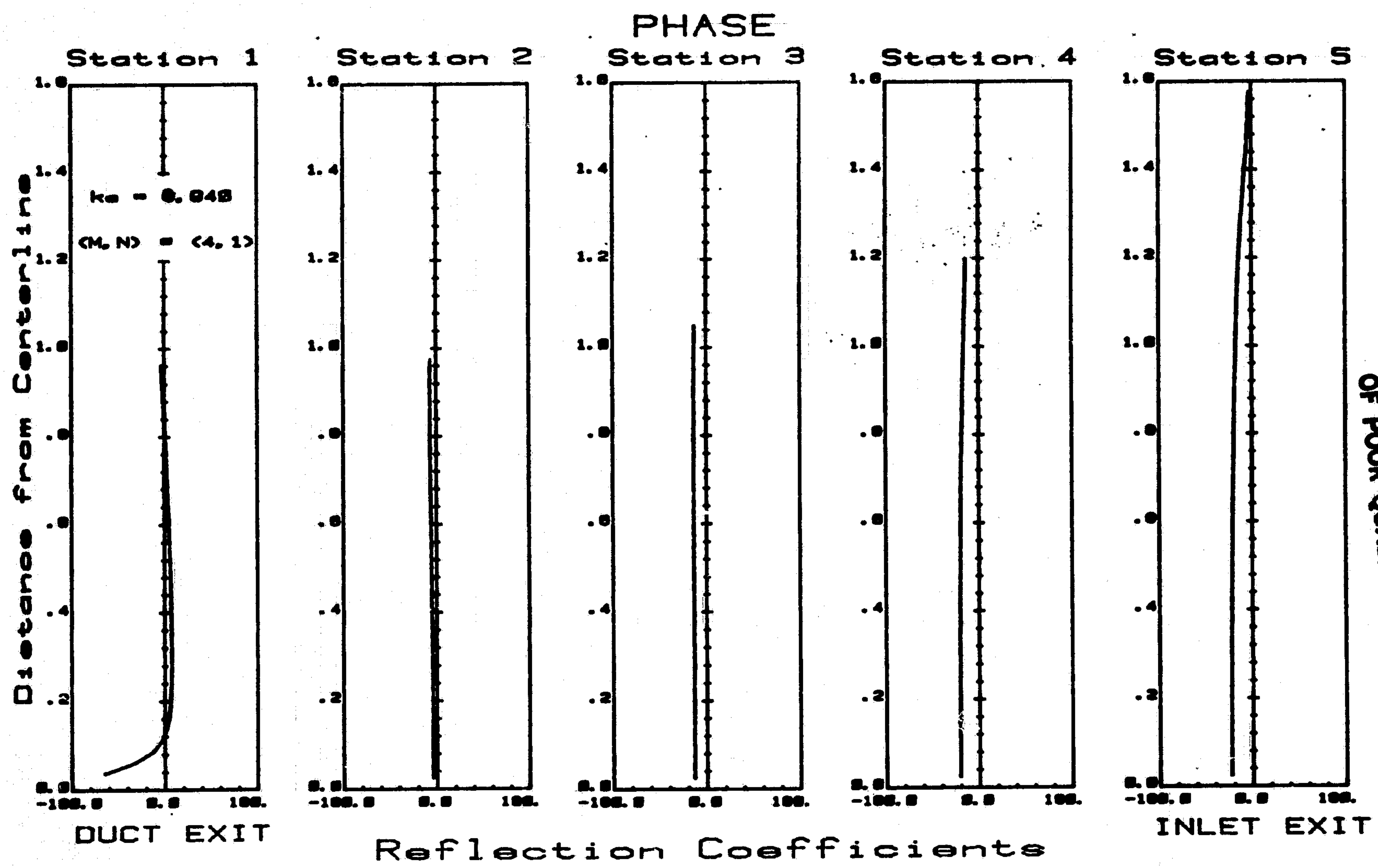

MODULUS
Station 1
Station 2
Station 3
Station 4
Station 5
(M, N) = (4, 1)
Distance from Centerline
DUCT EXIT
INLET EXIT
Reflection Coefficients
LANGLEY BELLMOUTH

Fig. 4i



LANGLEY BELLMOUTH

Fig. 4j

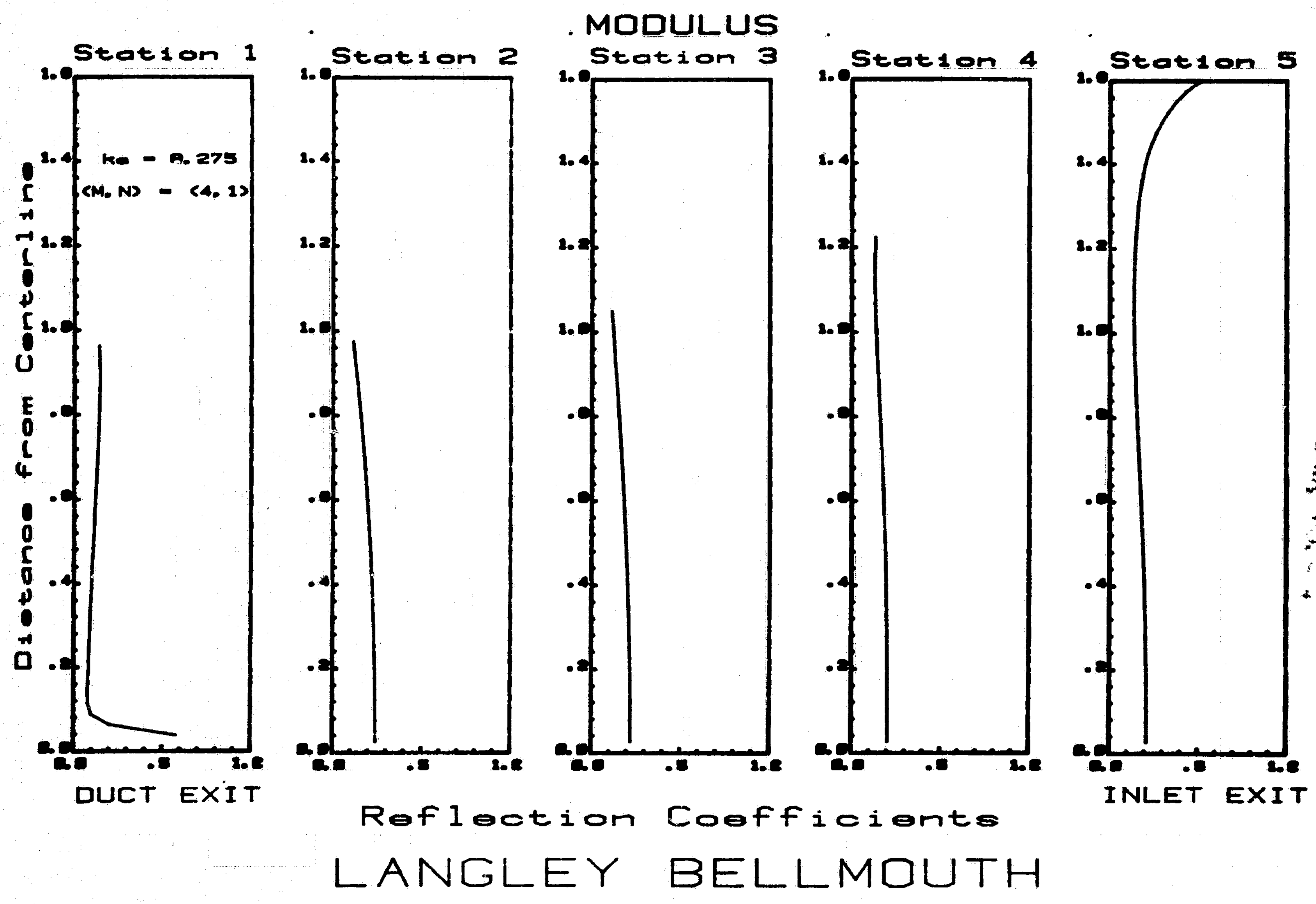

MODULUS
Station 1
Station 2
Station 3
Station 4
Station 5
ks = 0.275
(M, N) = (4, 1)
Distance from Centerline
DUCT EXIT
INLET EXIT
Reflection Coefficients
LANGLEY BELLMOUTH

Fig. 4k

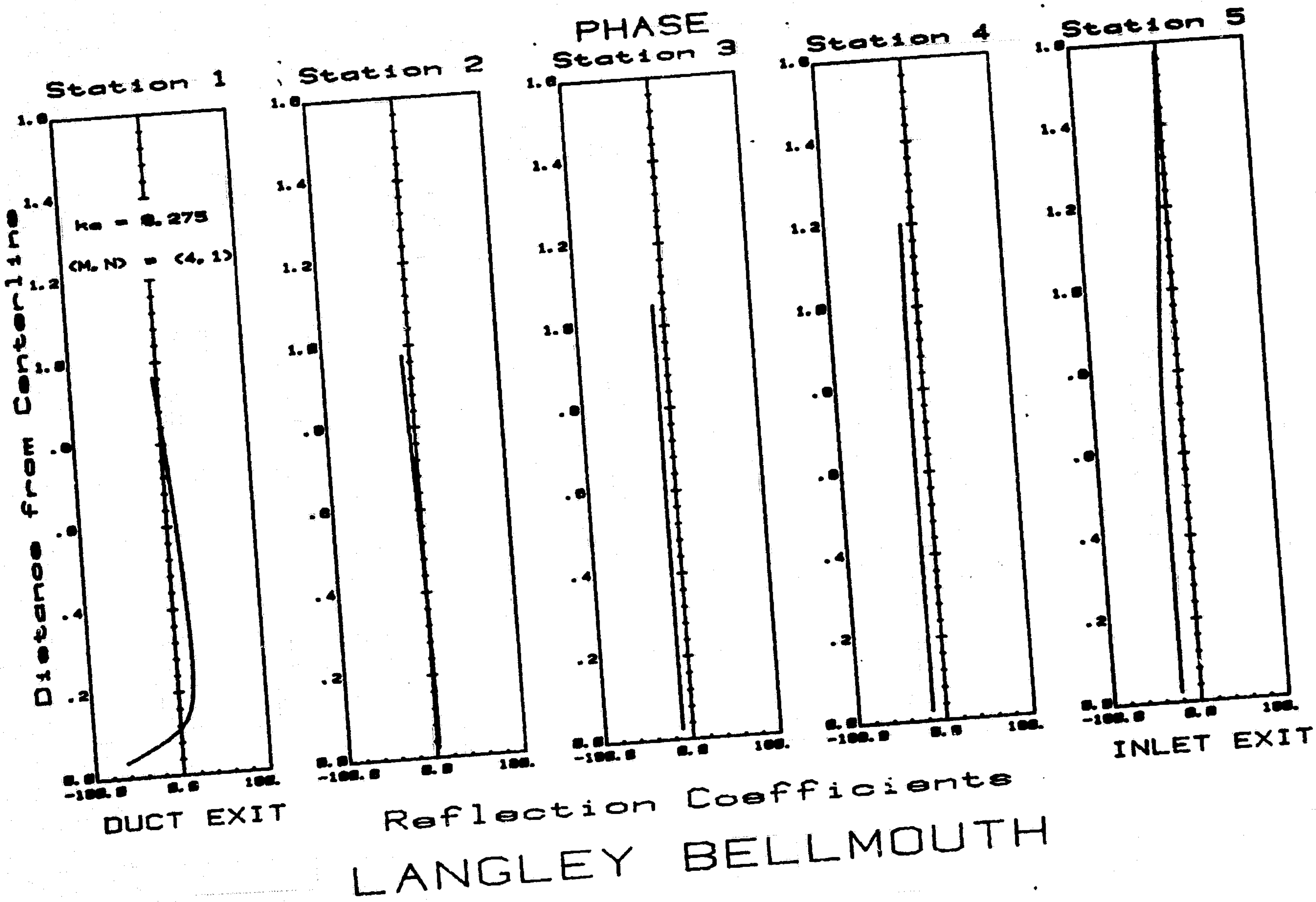

PHASE
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 0.275
(M, N) = (4, 1)
Distance from Centerline
-100.0
0.0
100.
DUCT EXIT
INLET EXIT
Reflection Coefficients
LANGLEY BELLMOUTH

Fig. 41

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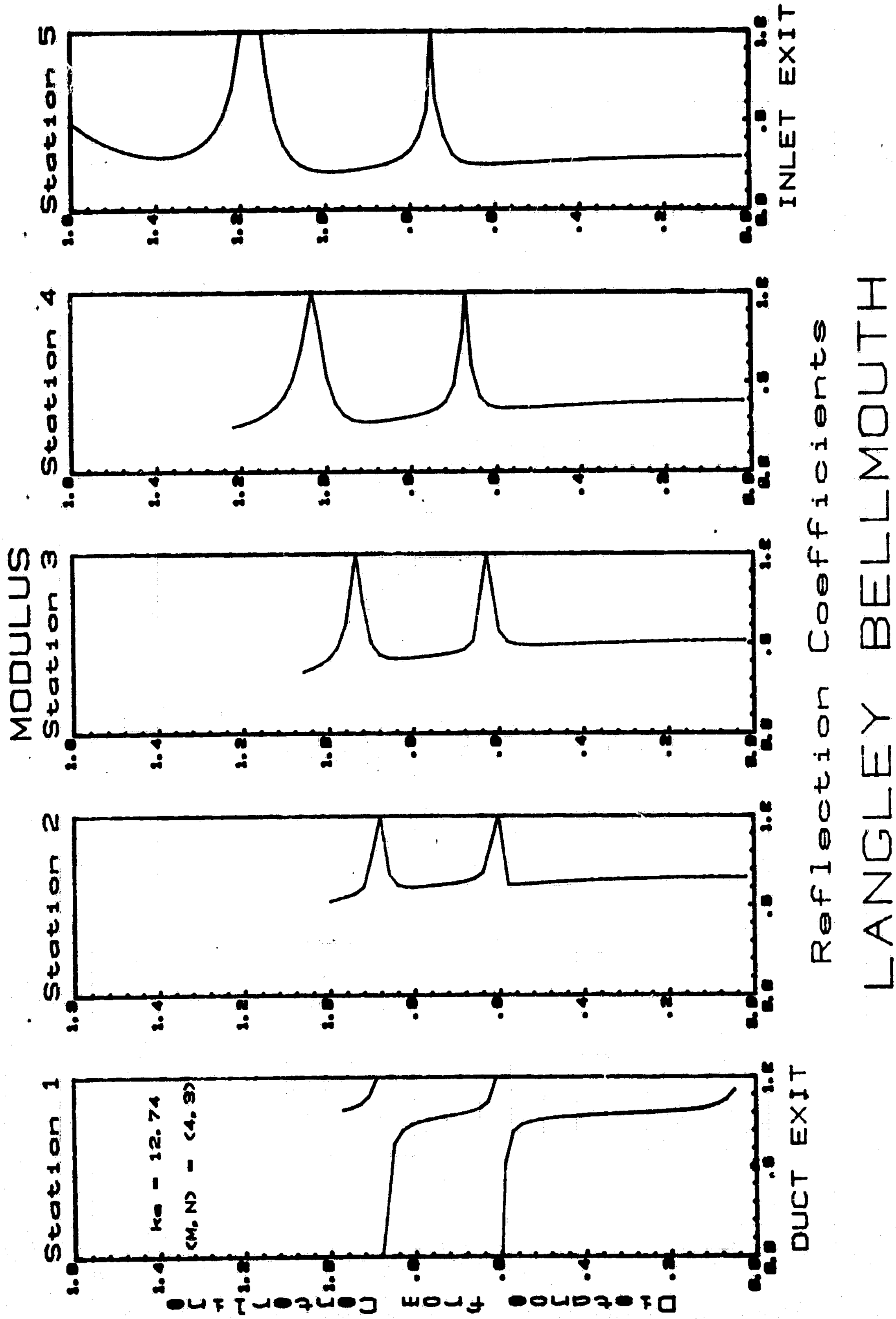


Fig. 5a

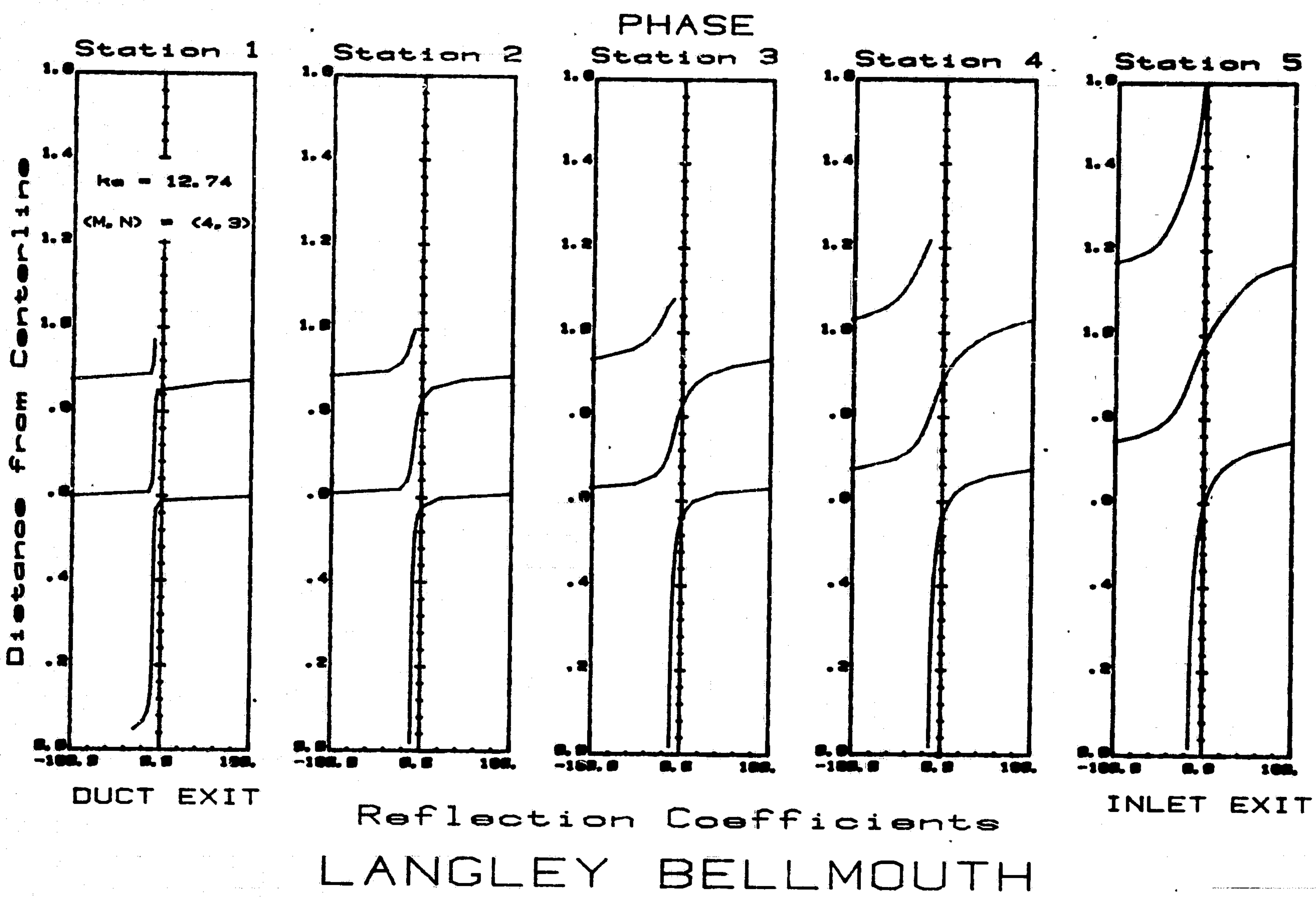

PHASE
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 12.74
(M, N) = (4, 3)
Distance from Centerline
1.6
1.4
1.2
1.0
.8
.6
.4
.2
0.0
-180.0
0.0
180.
DUCT EXIT
INLET EXIT
Reflection Coefficients
LANGLEY BELLMOUTH

Fig. 5b

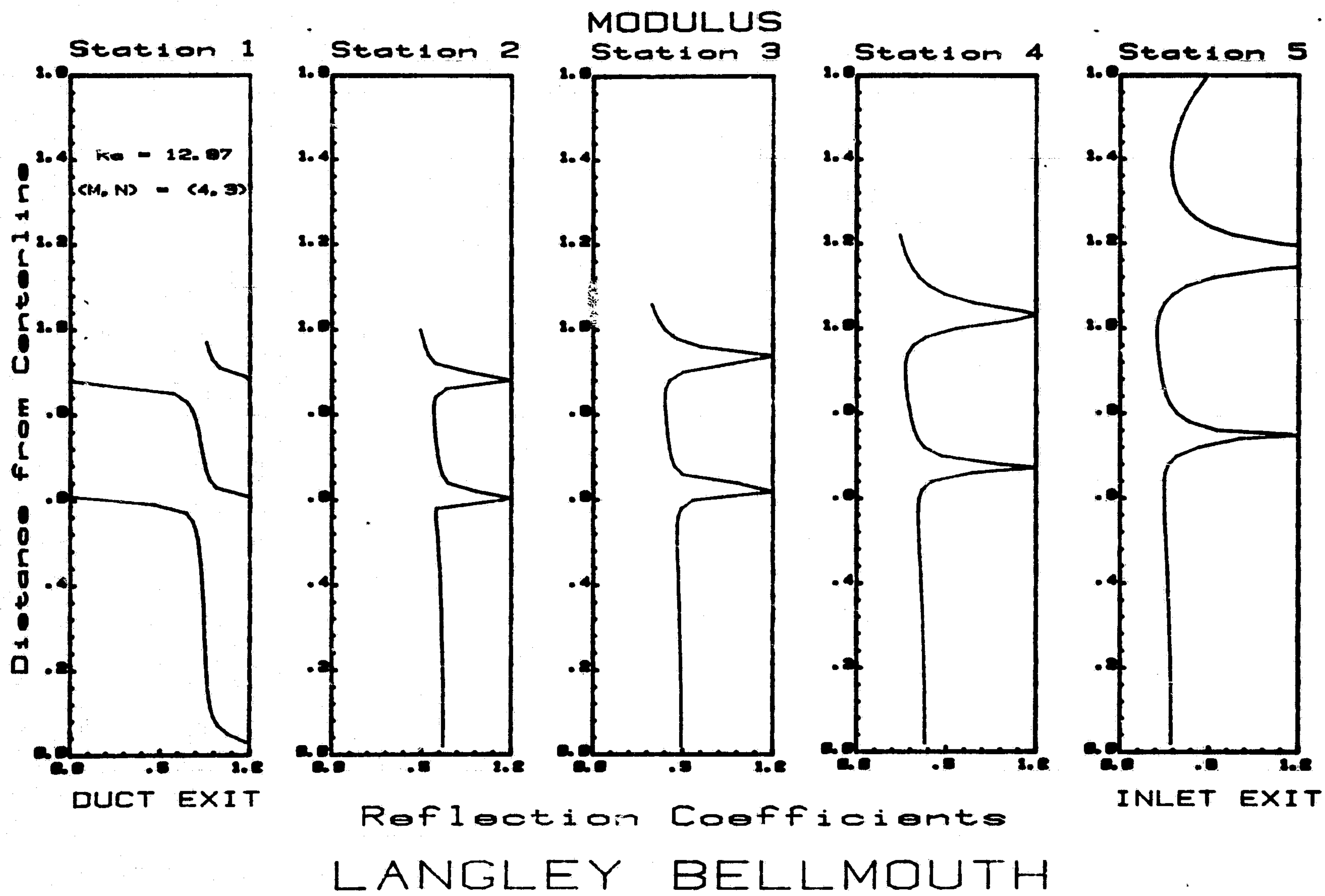
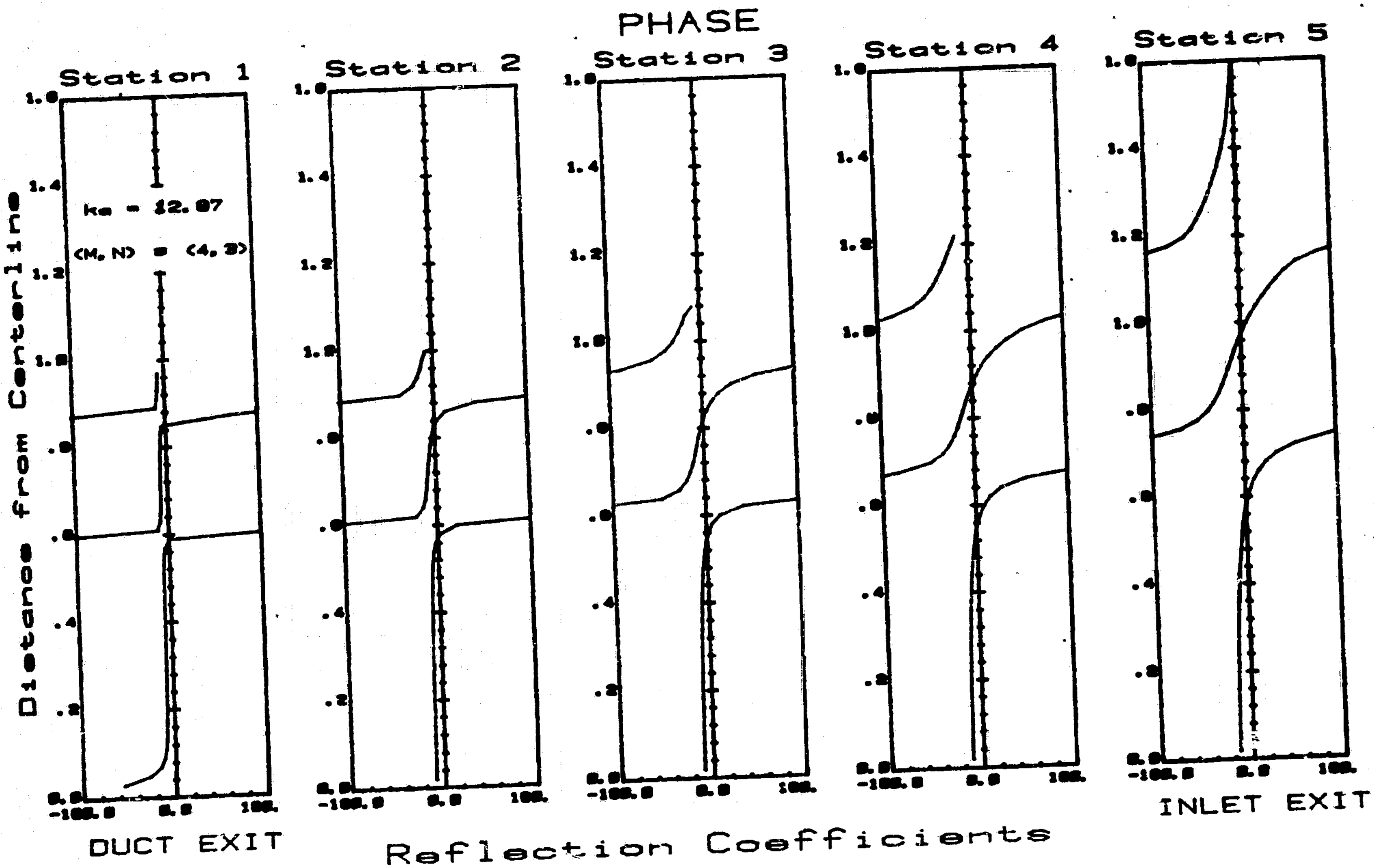

MODULUS
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 12.87
(M, N) = (4, 3)
Distance from Centerline
DUCT EXIT
INLET EXIT
Reflection Coefficients
LANGLEY BELLMOUTH

Fig. 5c



LANGLEY BELLMOUTH

Fig. 5d

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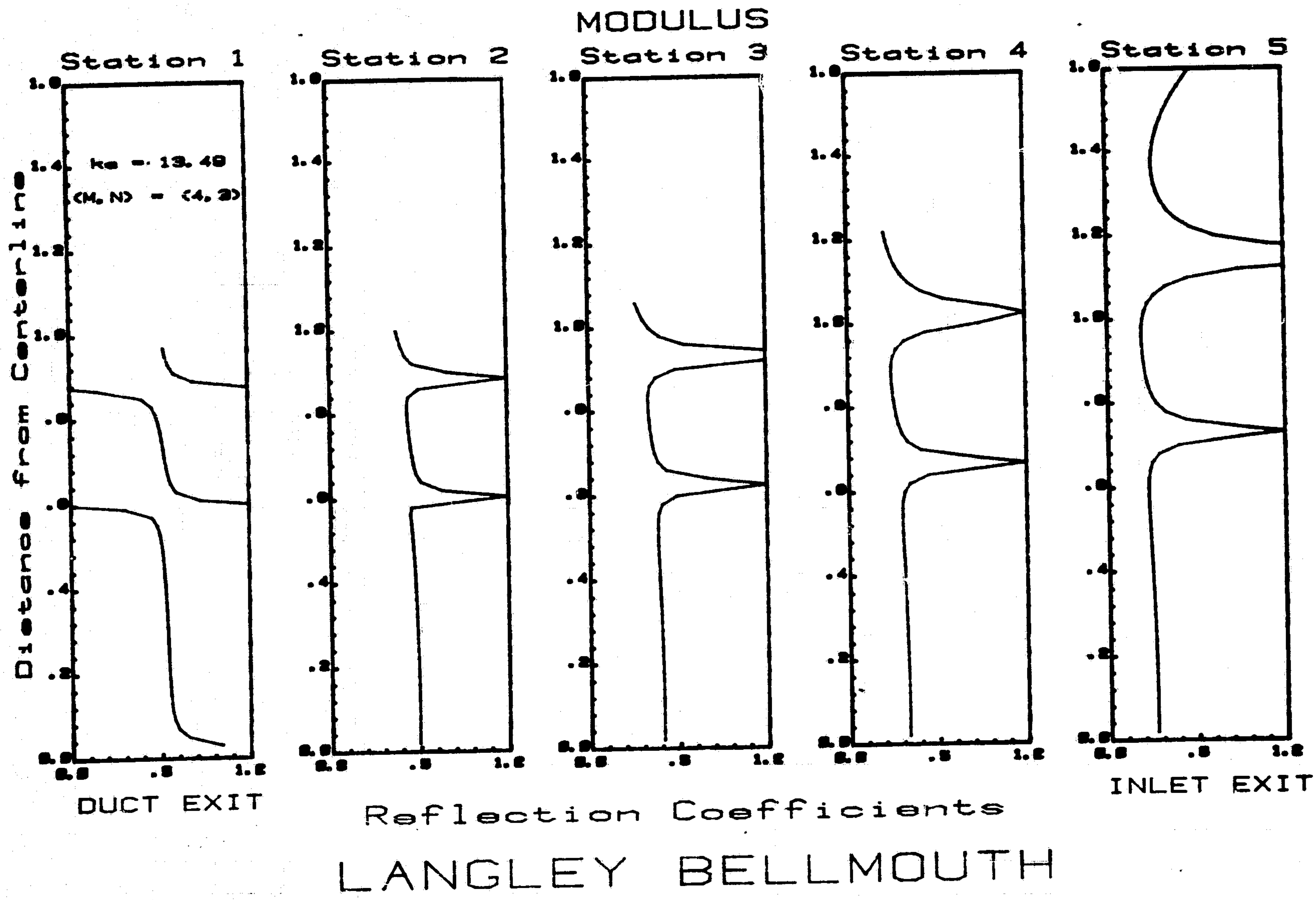


Fig. 5e

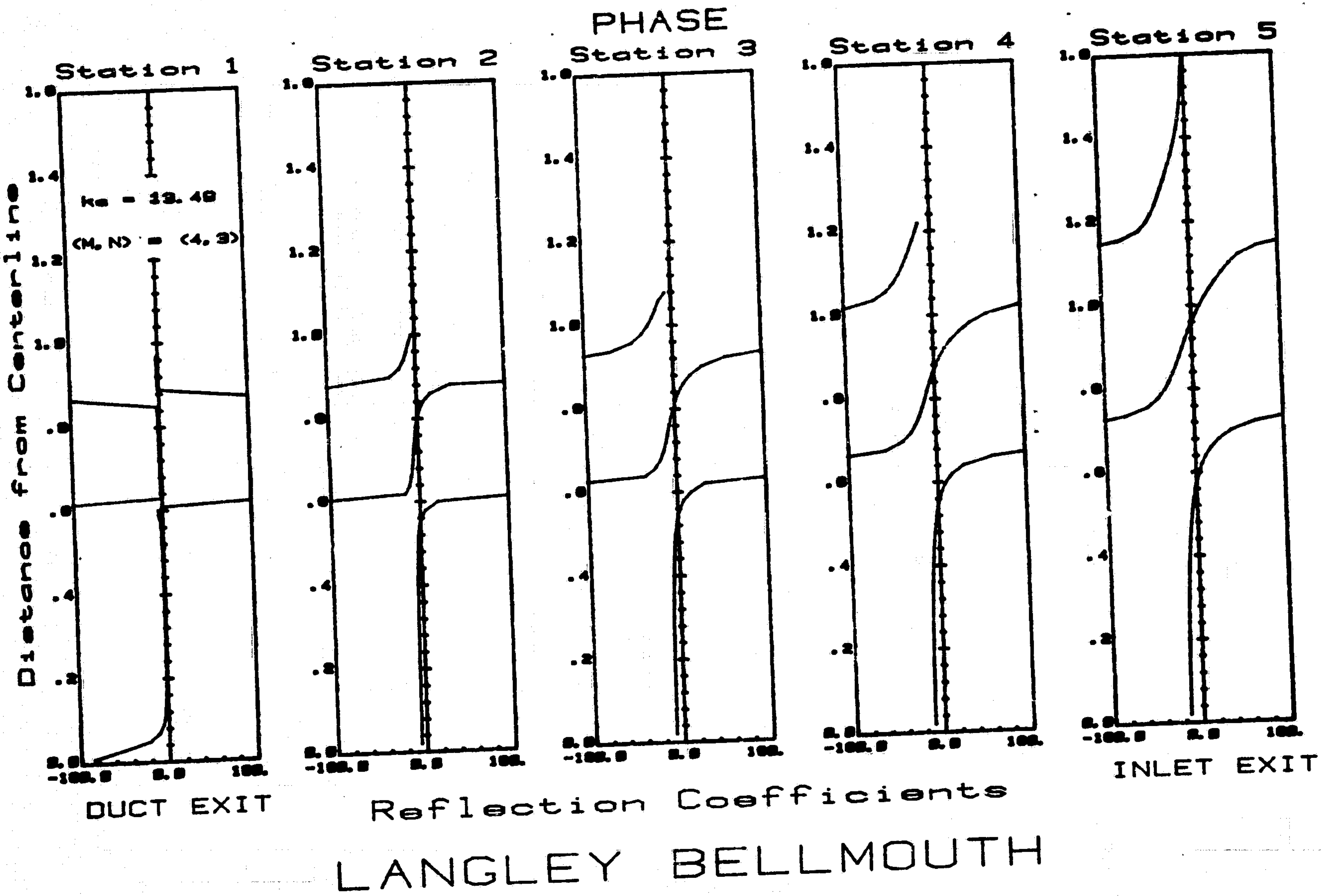
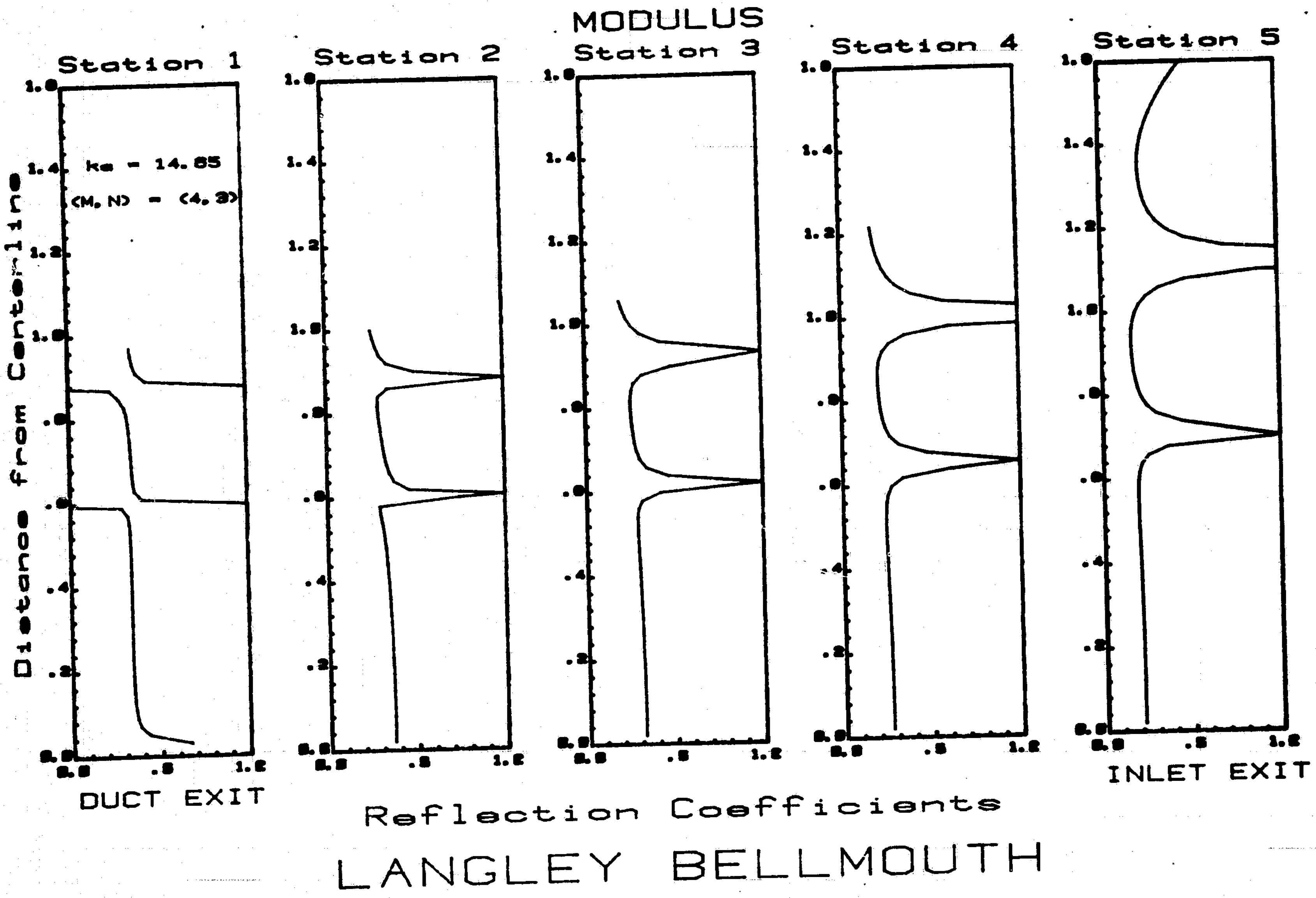

PHASE
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 13.40
(M, N) = (4, 3)
Distance from Centerline
1.6
1.4
1.2
1.0
.8
.6
.4
.2
0.0
-180.0
0.0
180.
DUCT EXIT
INLET EXIT
Reflection Coefficients
LANGLEY BELLMOUTH

Fig. 5f



MODULUS
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 14.85
(M, N) = (4, 3)
Distance from Centerline
DUCT EXIT
INLET EXIT
Reflection Coefficients
LANGLEY BELLMOUTH

Fig. 5g

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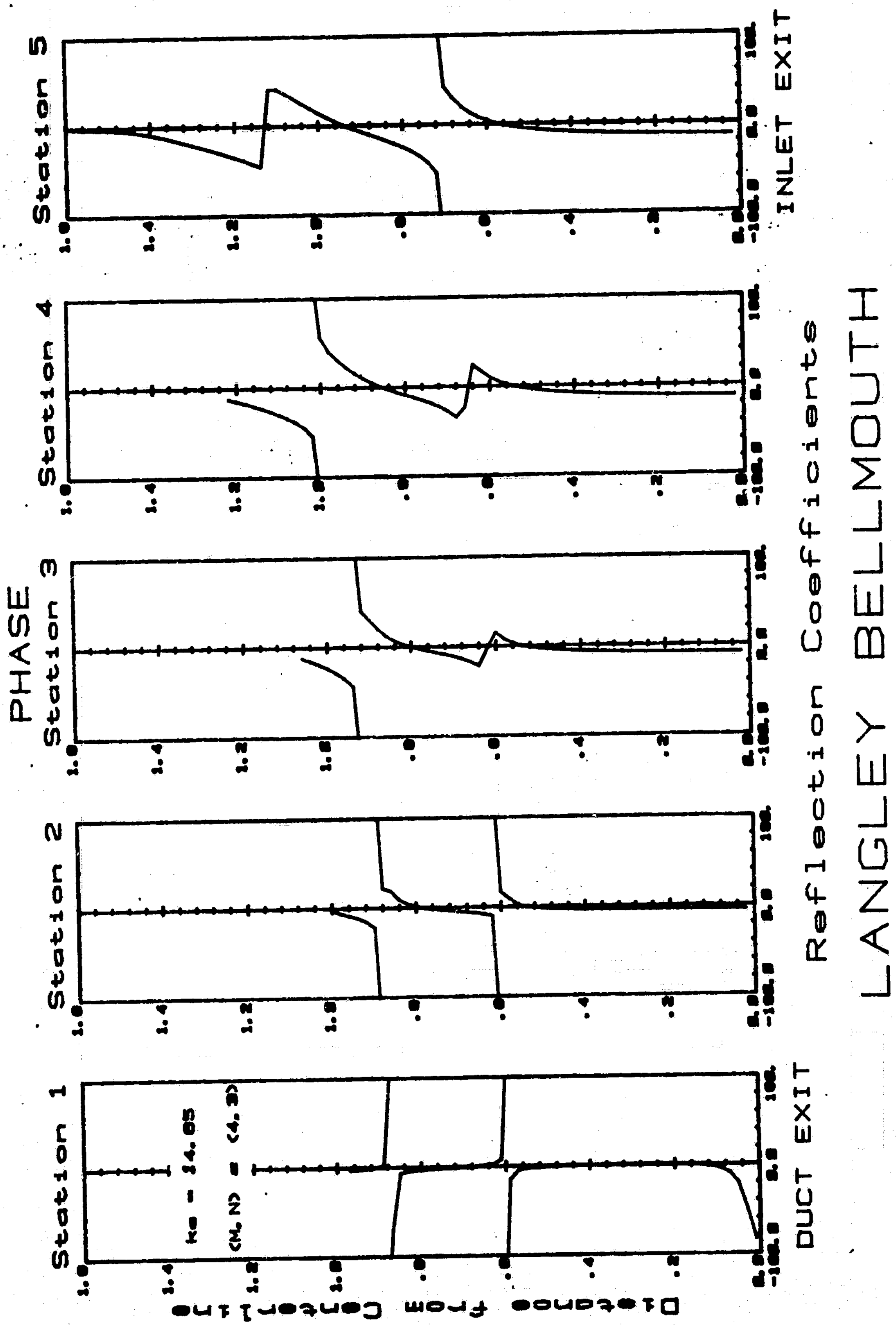


Fig. 5h

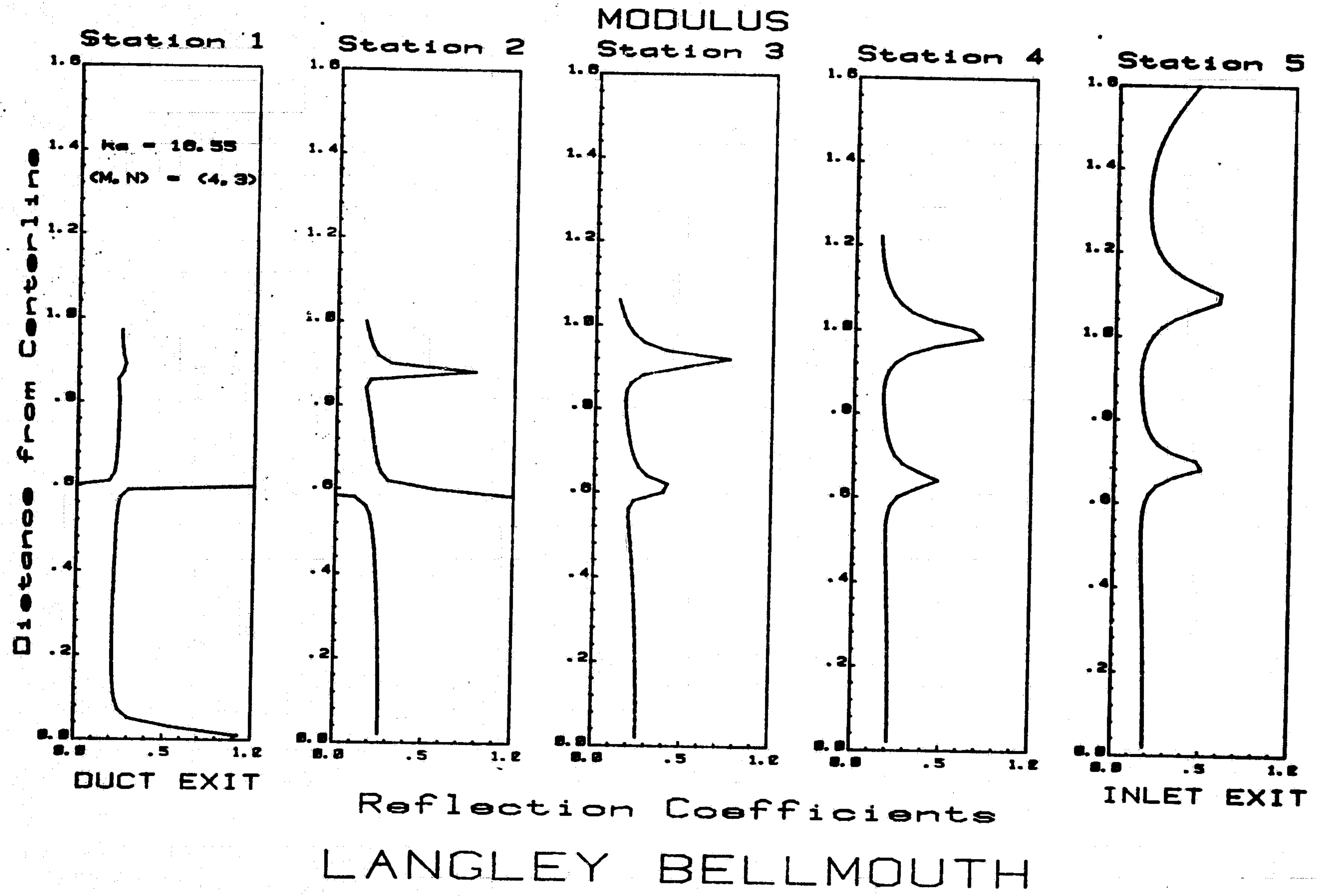

MODULUS
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 16.55
(M, N) = (4, 3)
Distance from Centerline
DUCT EXIT
INLET EXIT
Reflection Coefficients
LANGLEY BELLMOUTH

Fig. 51

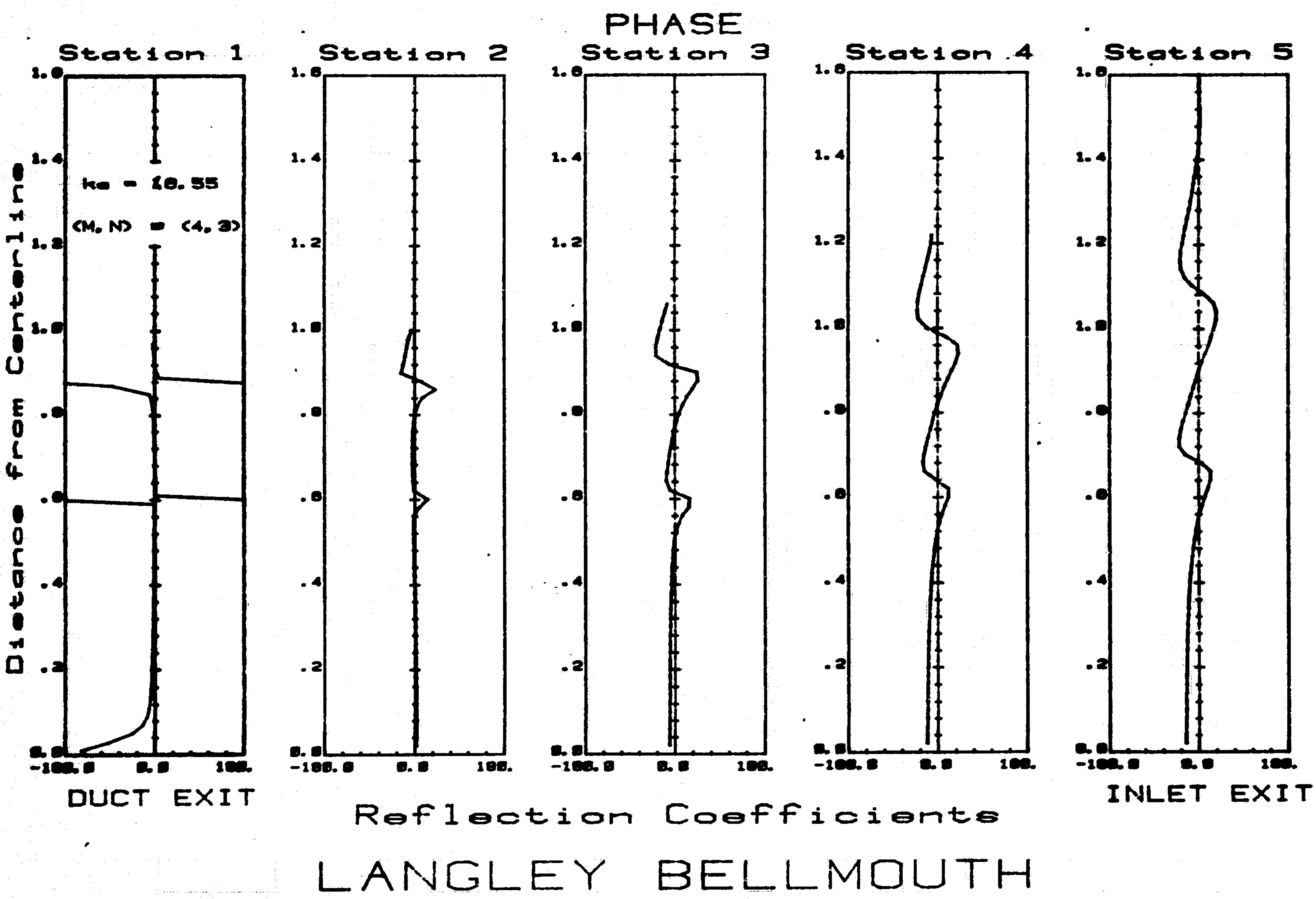
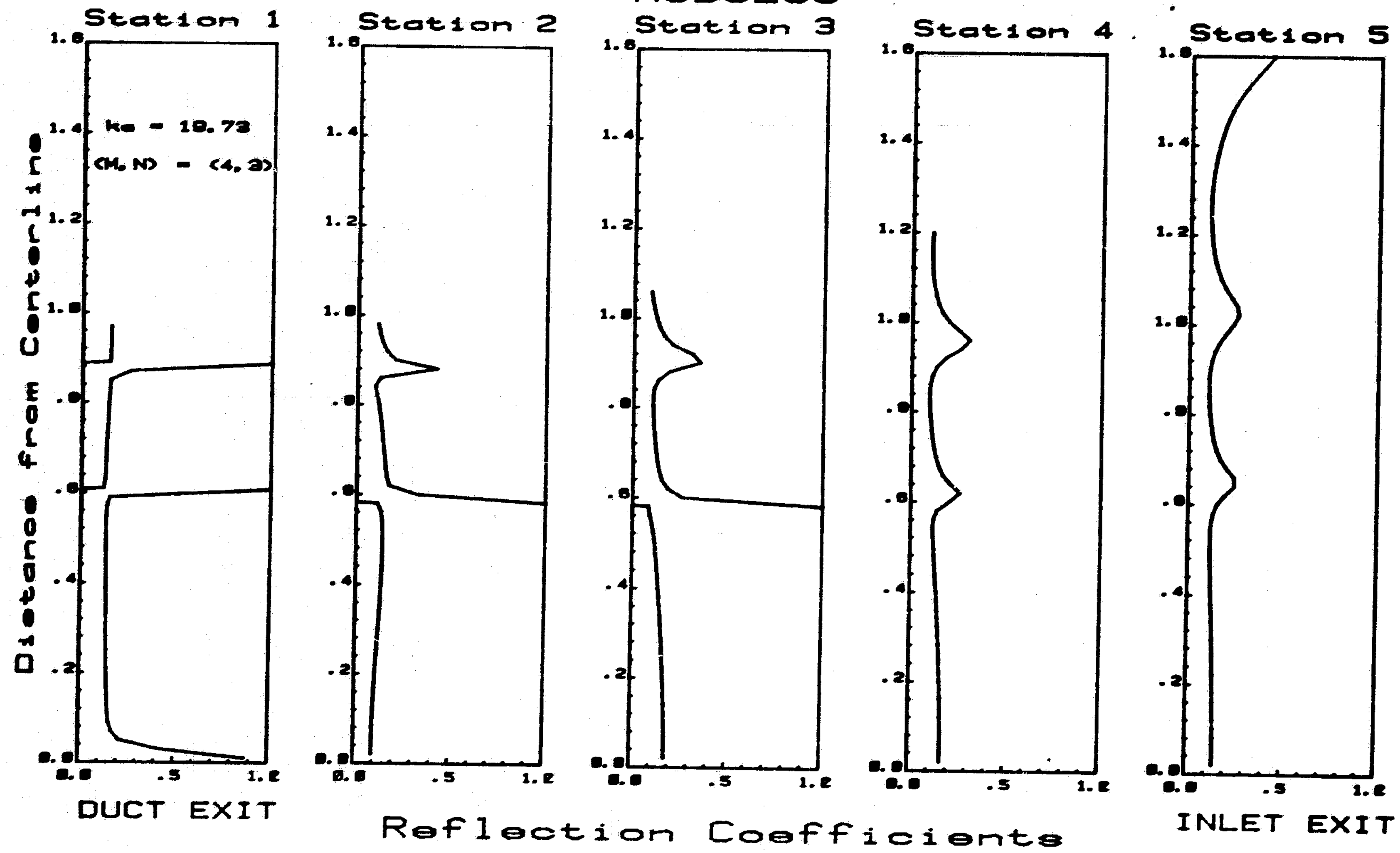

PHASE
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 10.55
(M, N) = (4, 3)
Distance from Centerline
1.6
1.4
1.2
1.0
.8
.6
.4
.2
0.0
-100.0
0.0
100.
DUCT EXIT
INLET EXIT
Reflection Coefficients
LANGLEY BELLMOUTH

Fig. 5j



LANGLEY BELLMOUTH

Fig. 5k

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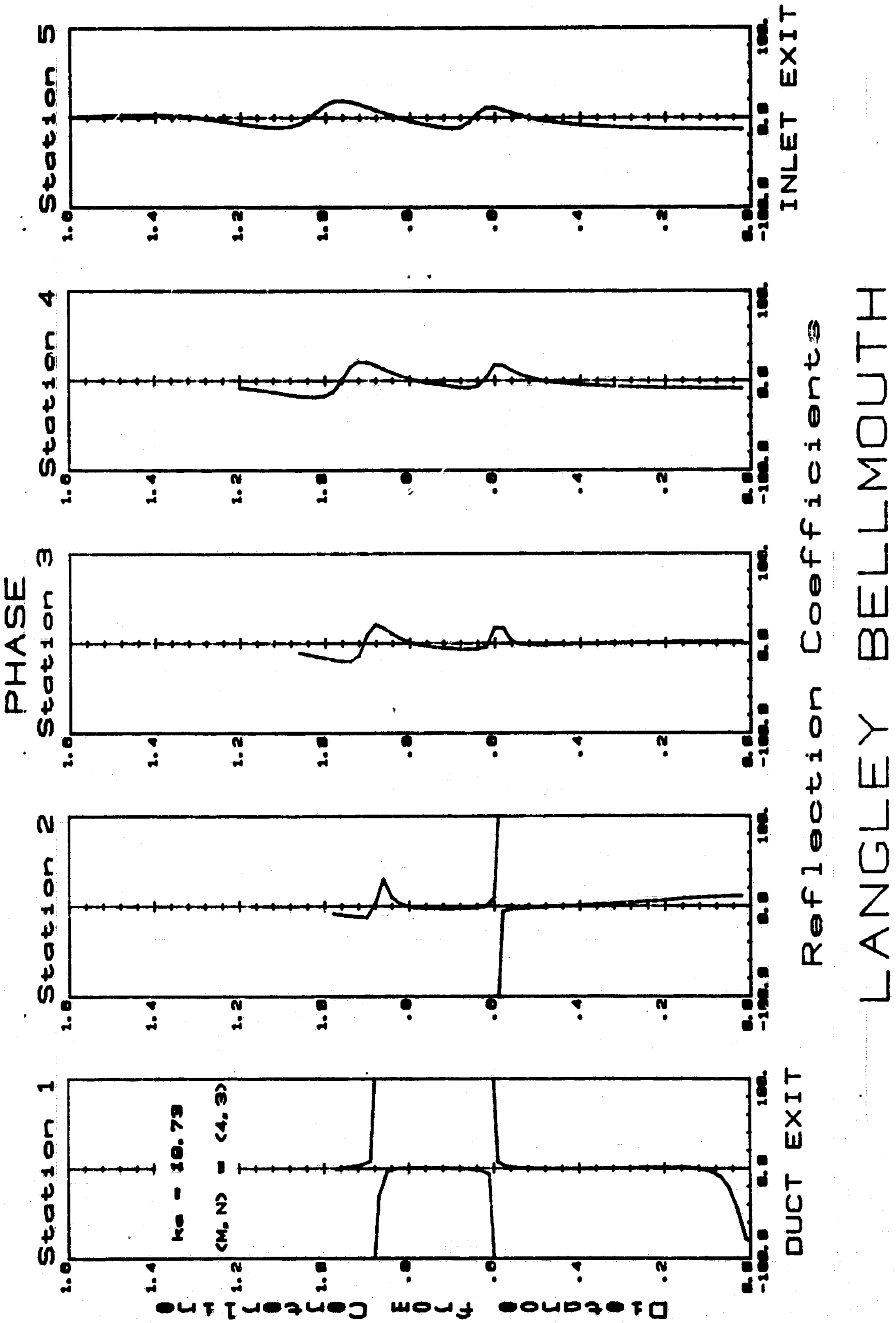

Fig. 51

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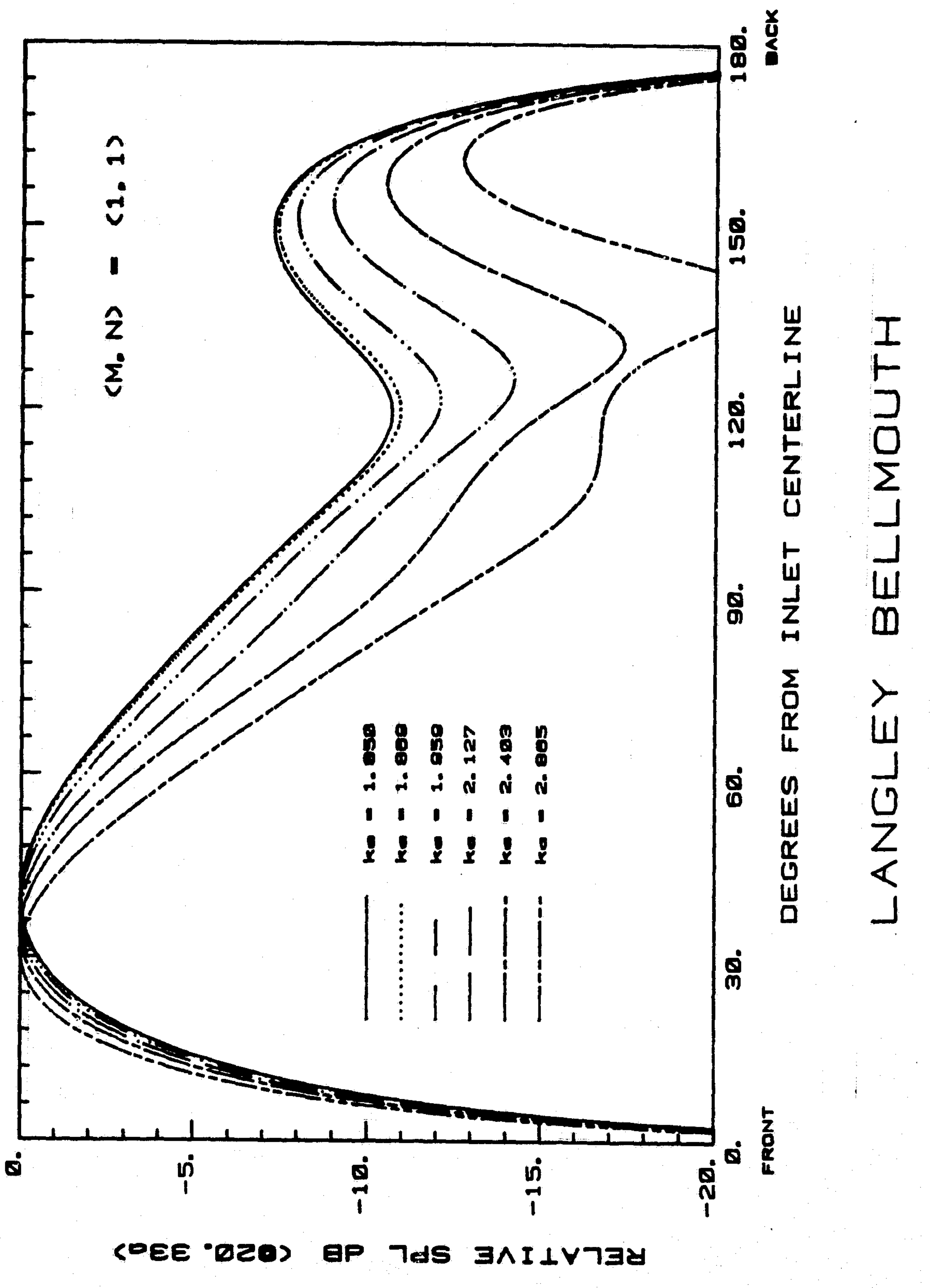

Fig. 6a

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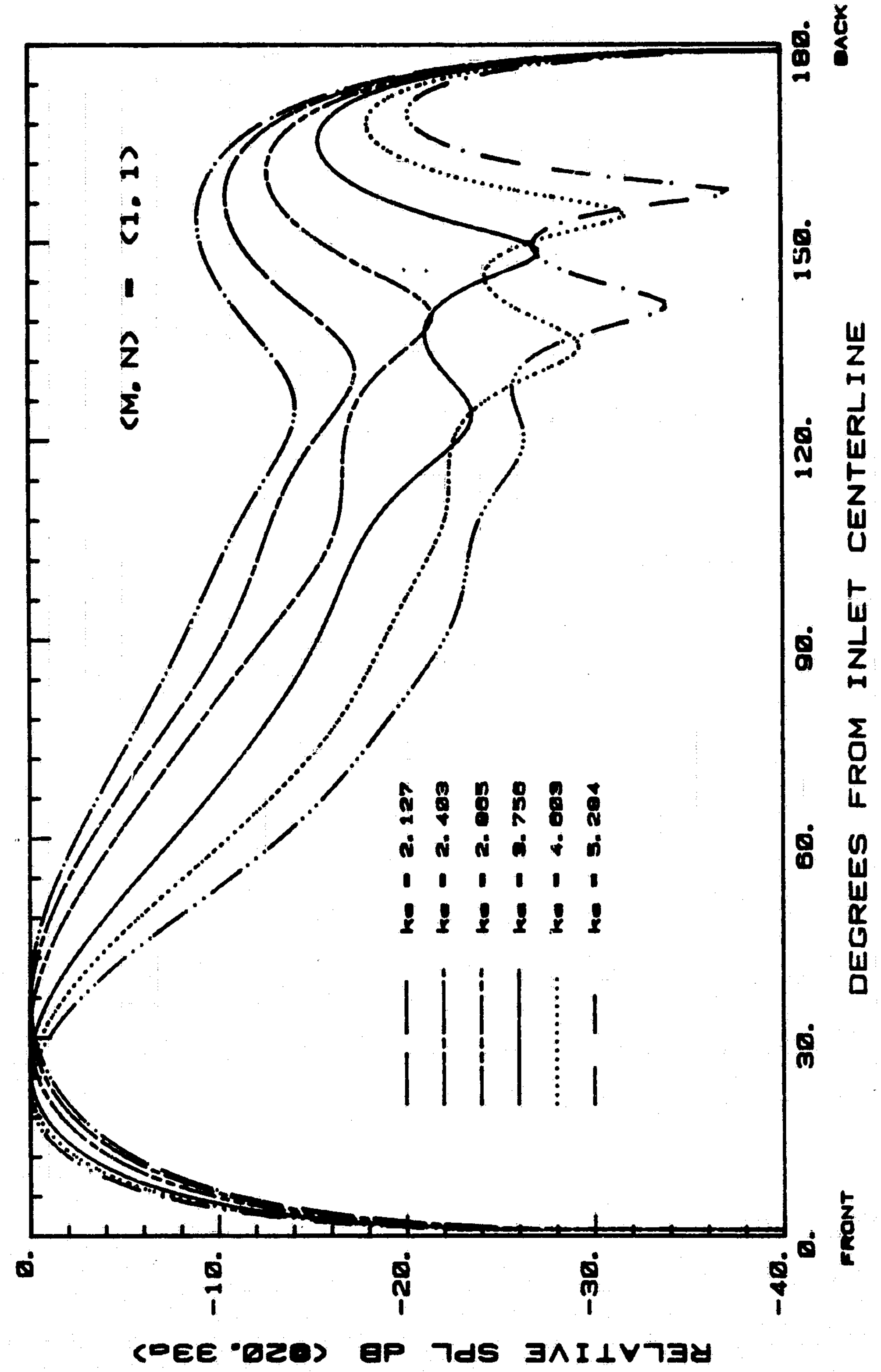
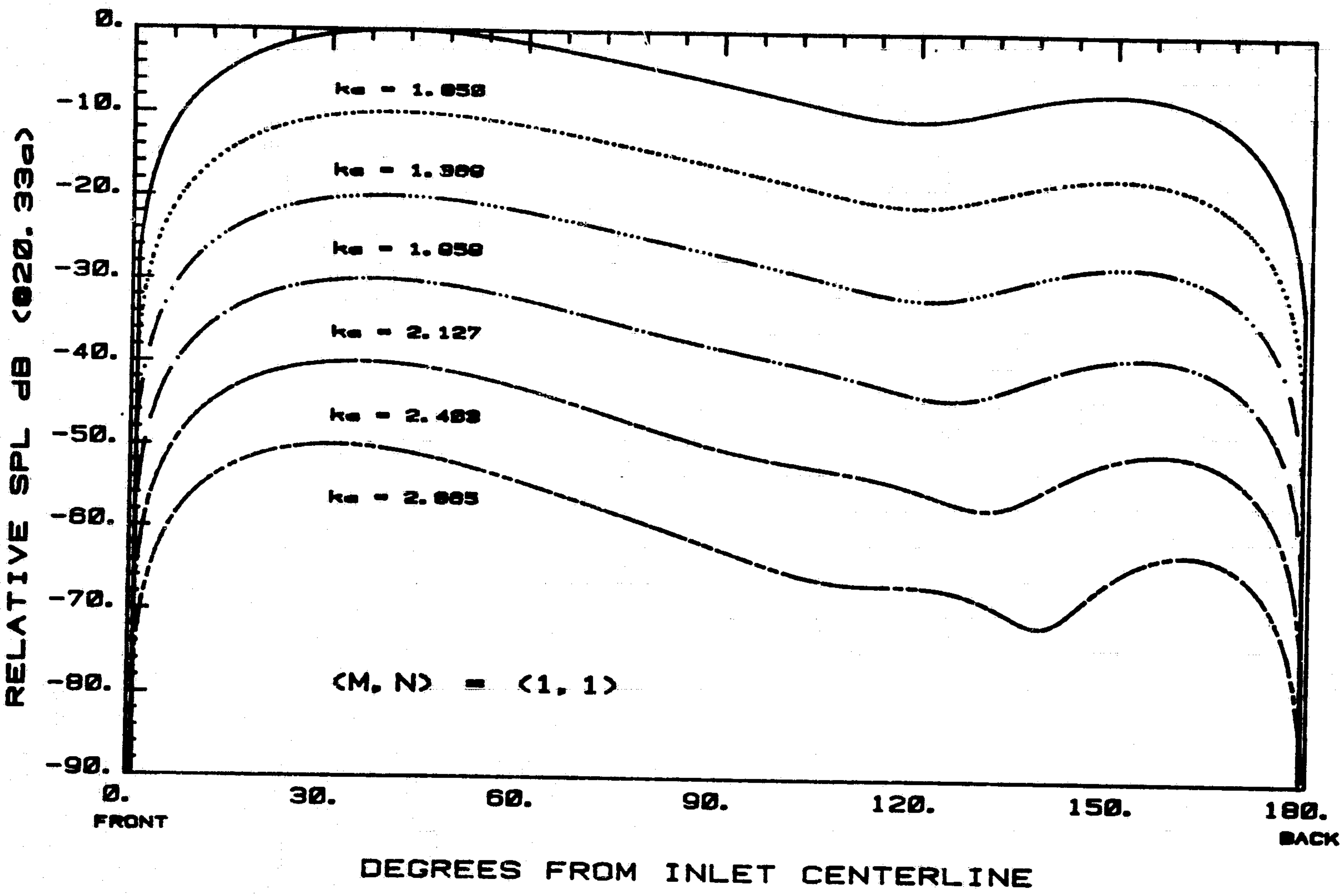


LANGLEY BELLMOUTH

Fig. 6b



LANGLEY BELLMOUTH

Fig. 6c

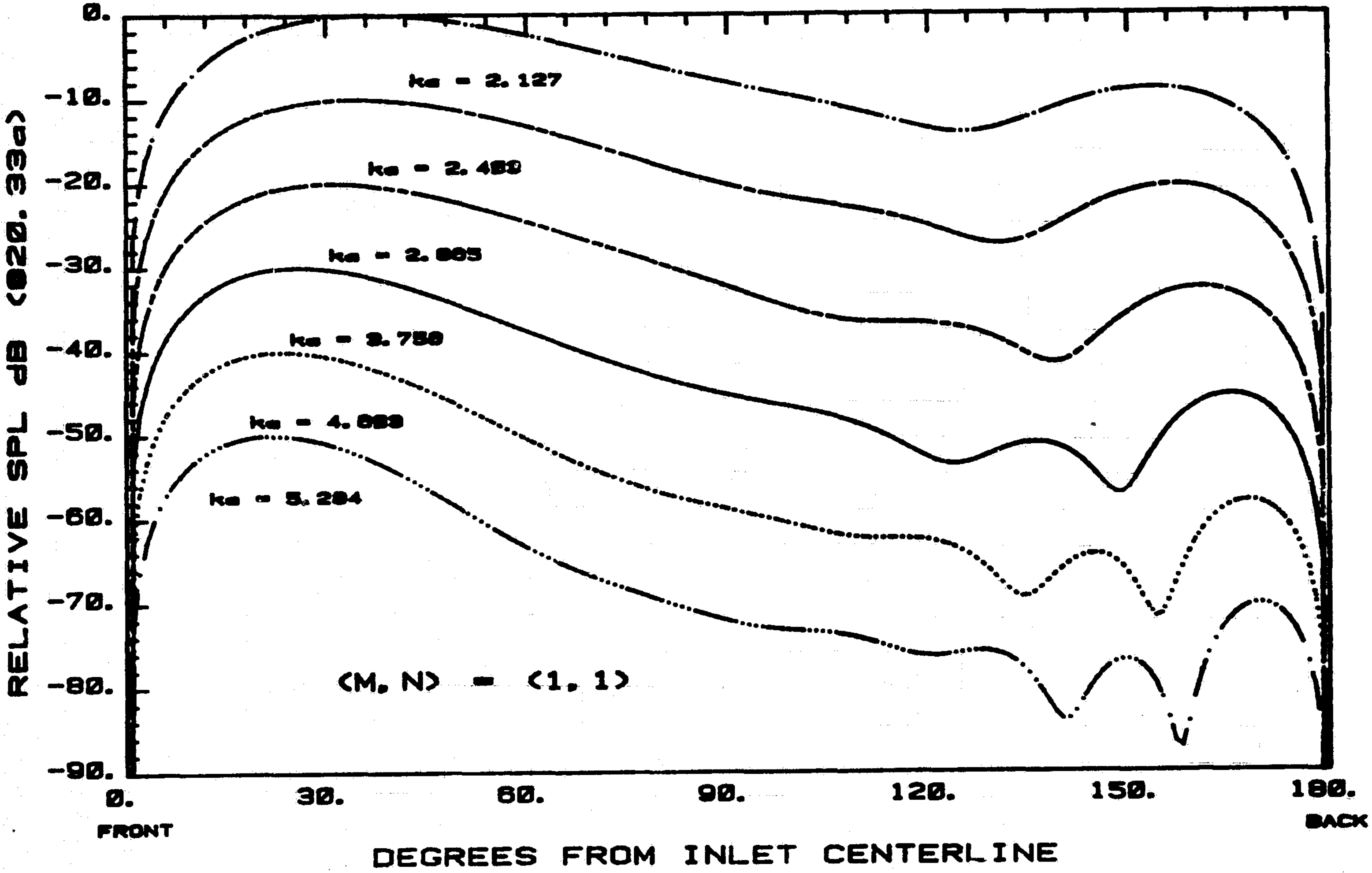


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Fig. 6d

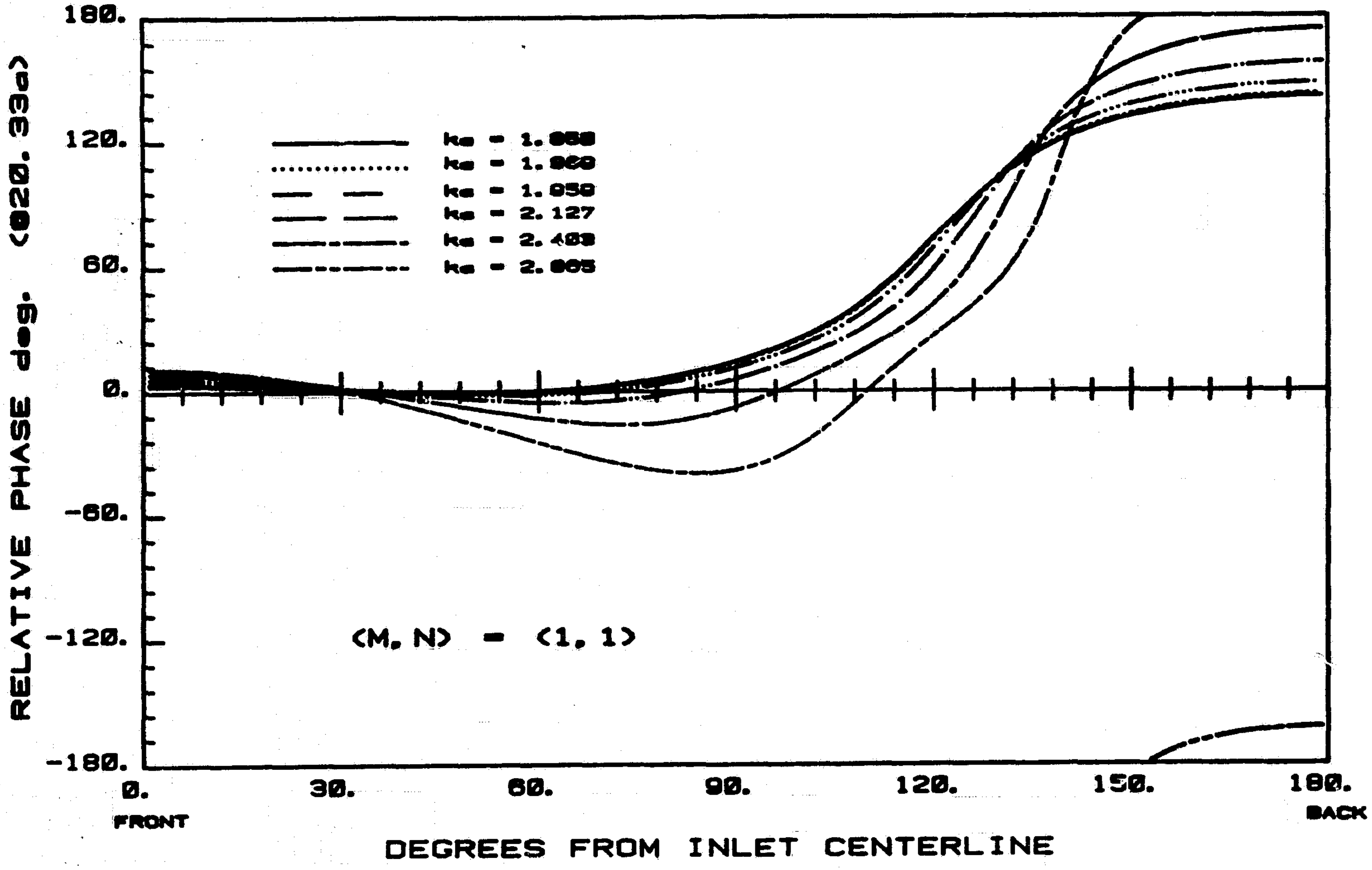

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Fig. 6e

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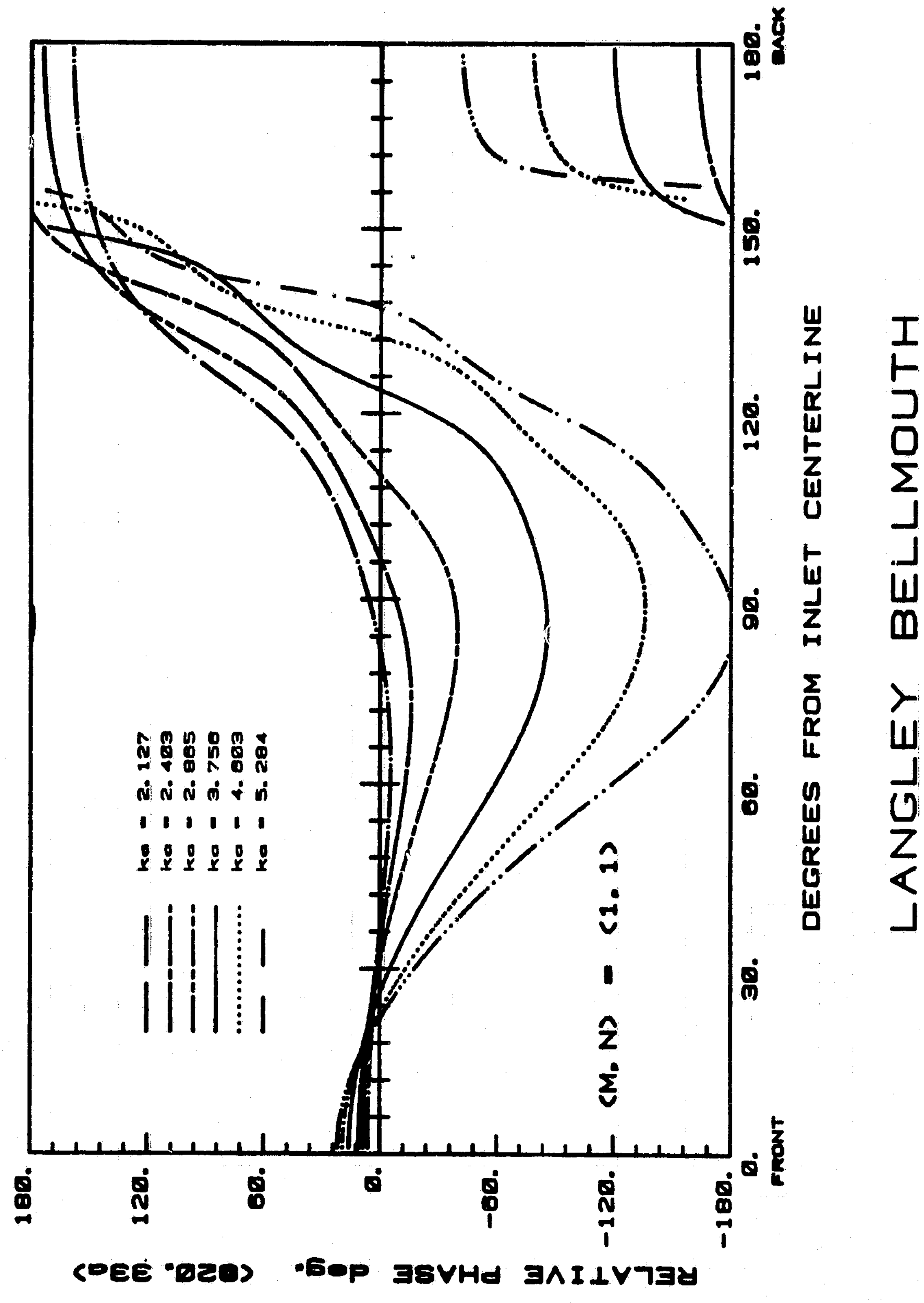

Fig. 6f

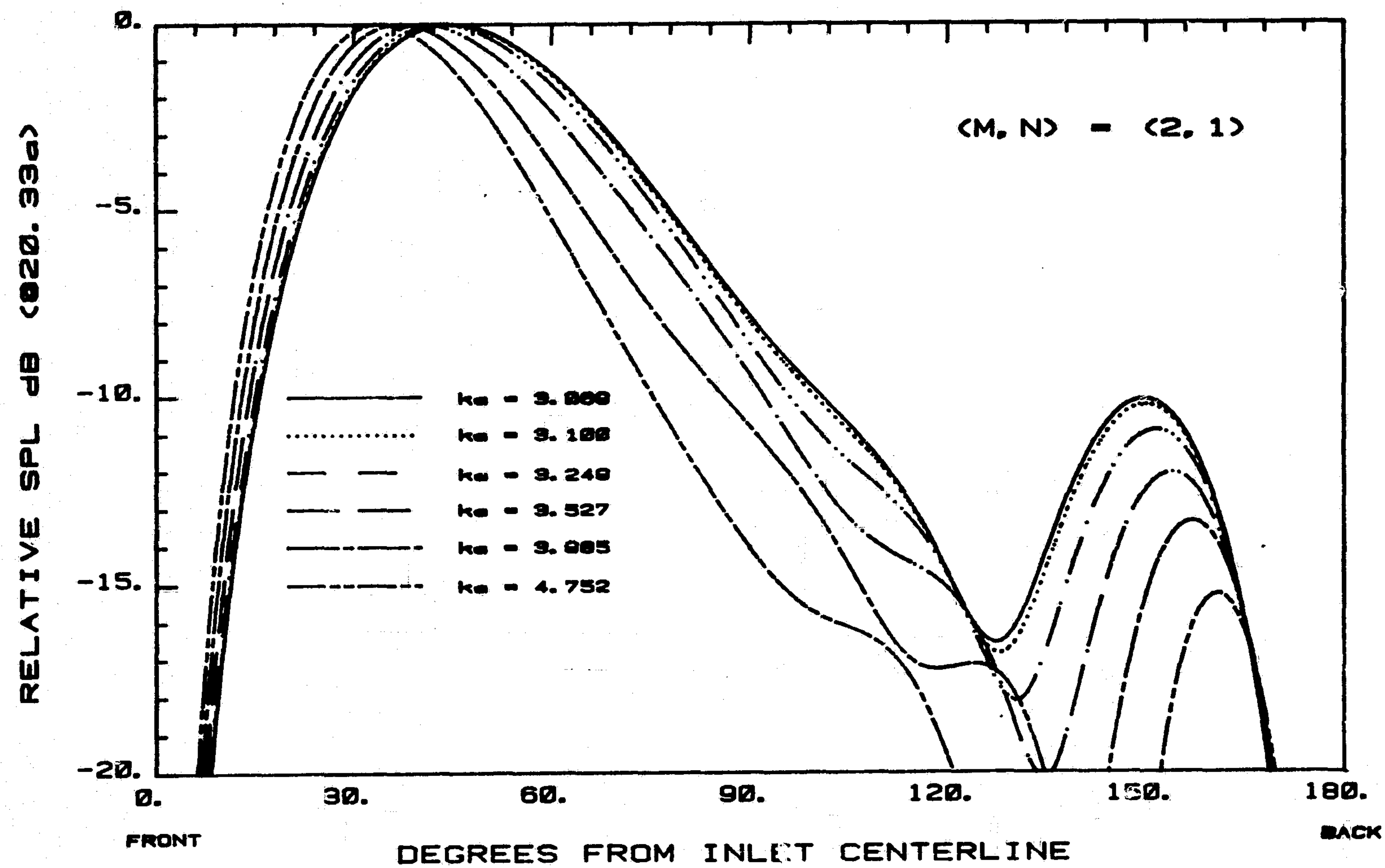

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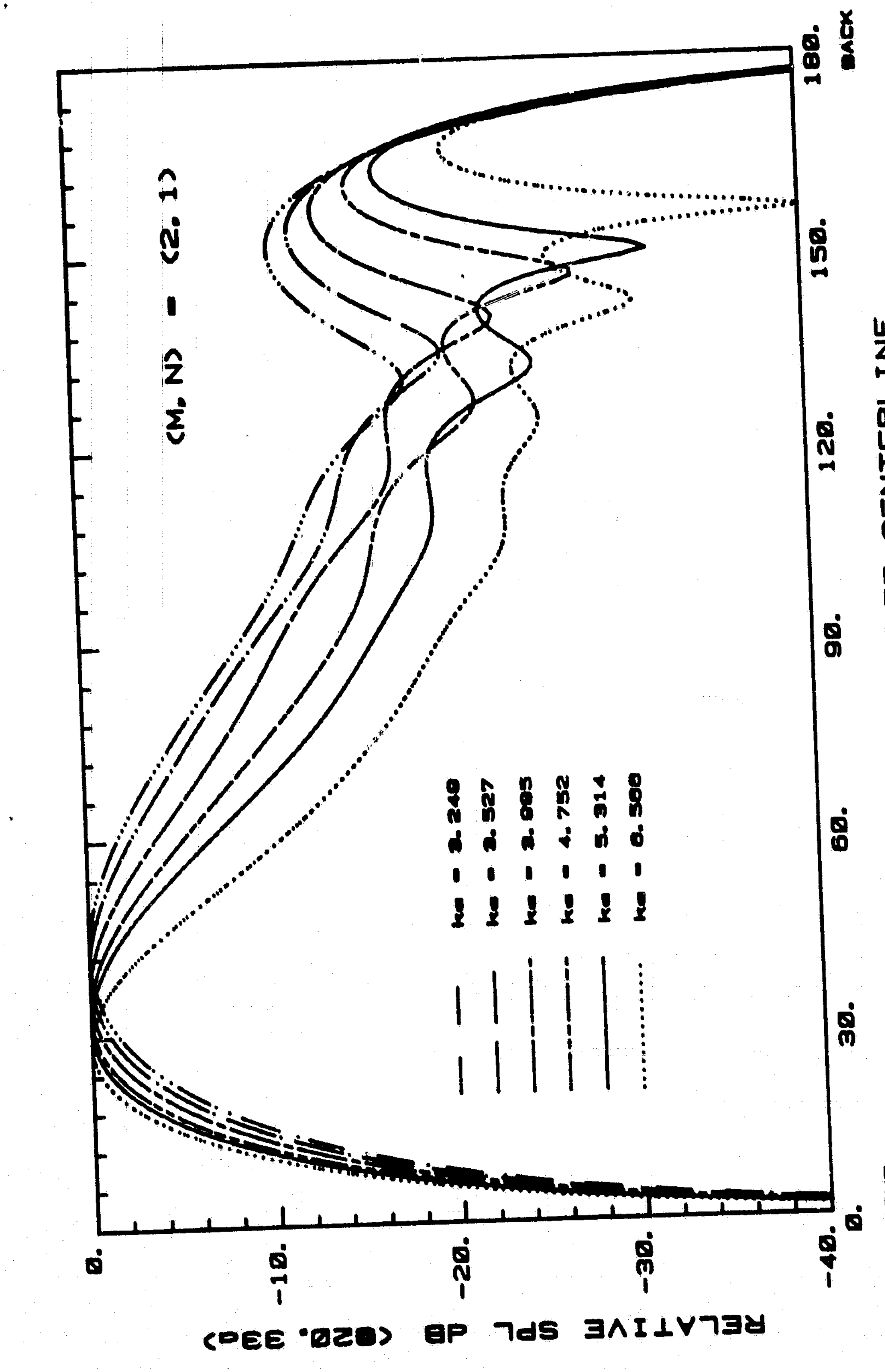
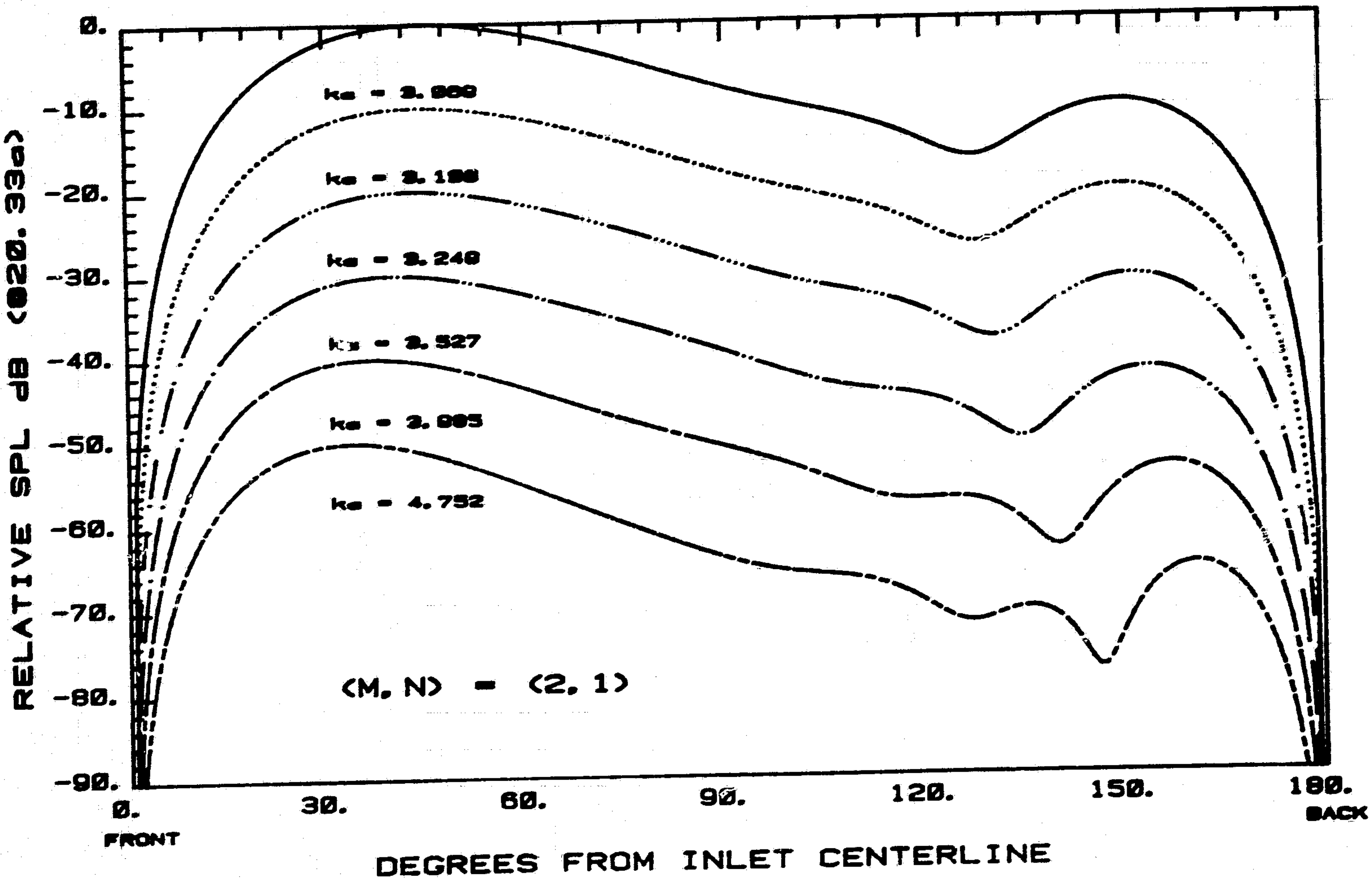
Fig. 7a



LANGLEY BELLMOUTH

Fig. 7b



LANGLEY BELLMOUTH

Fig. 7c

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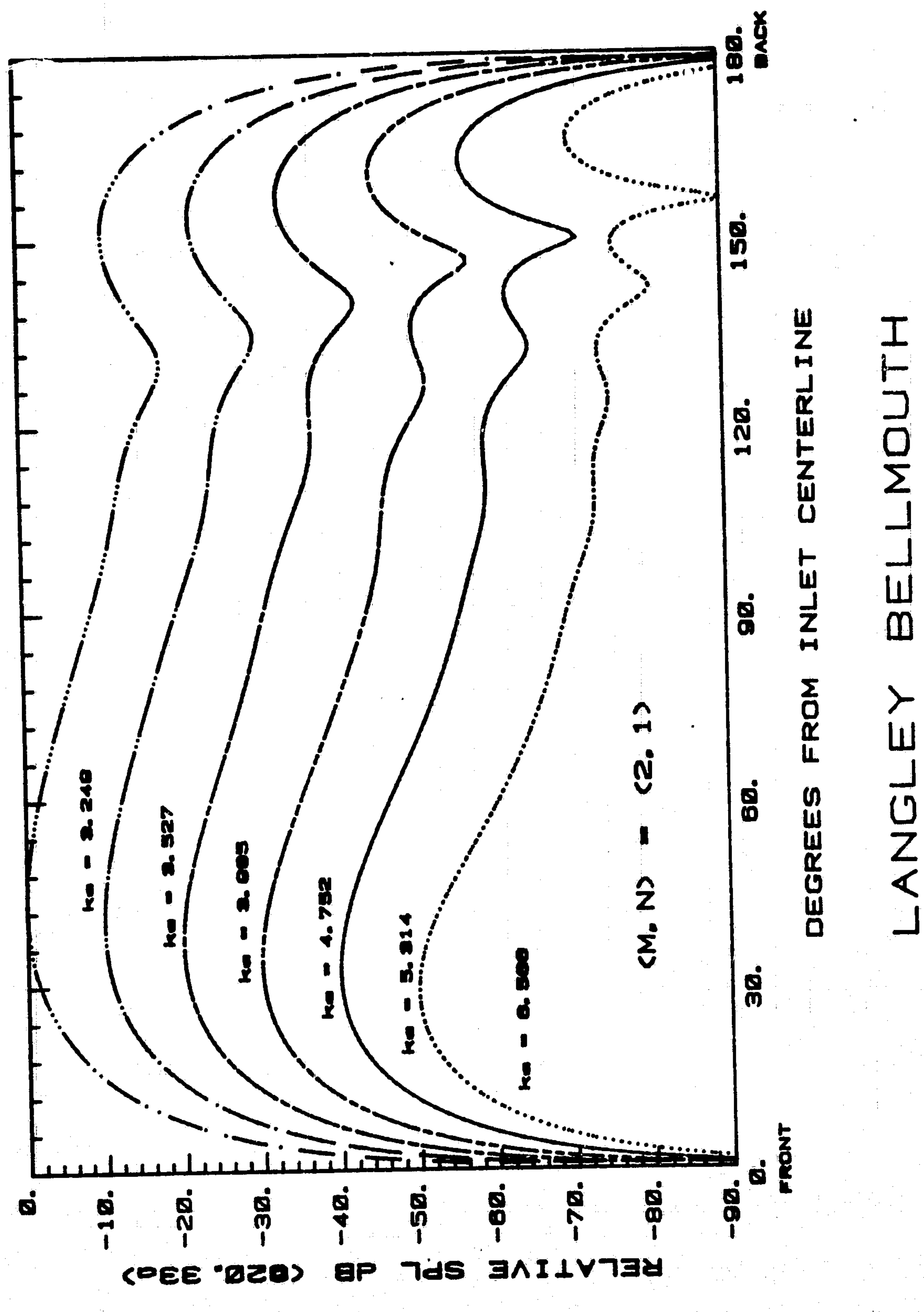
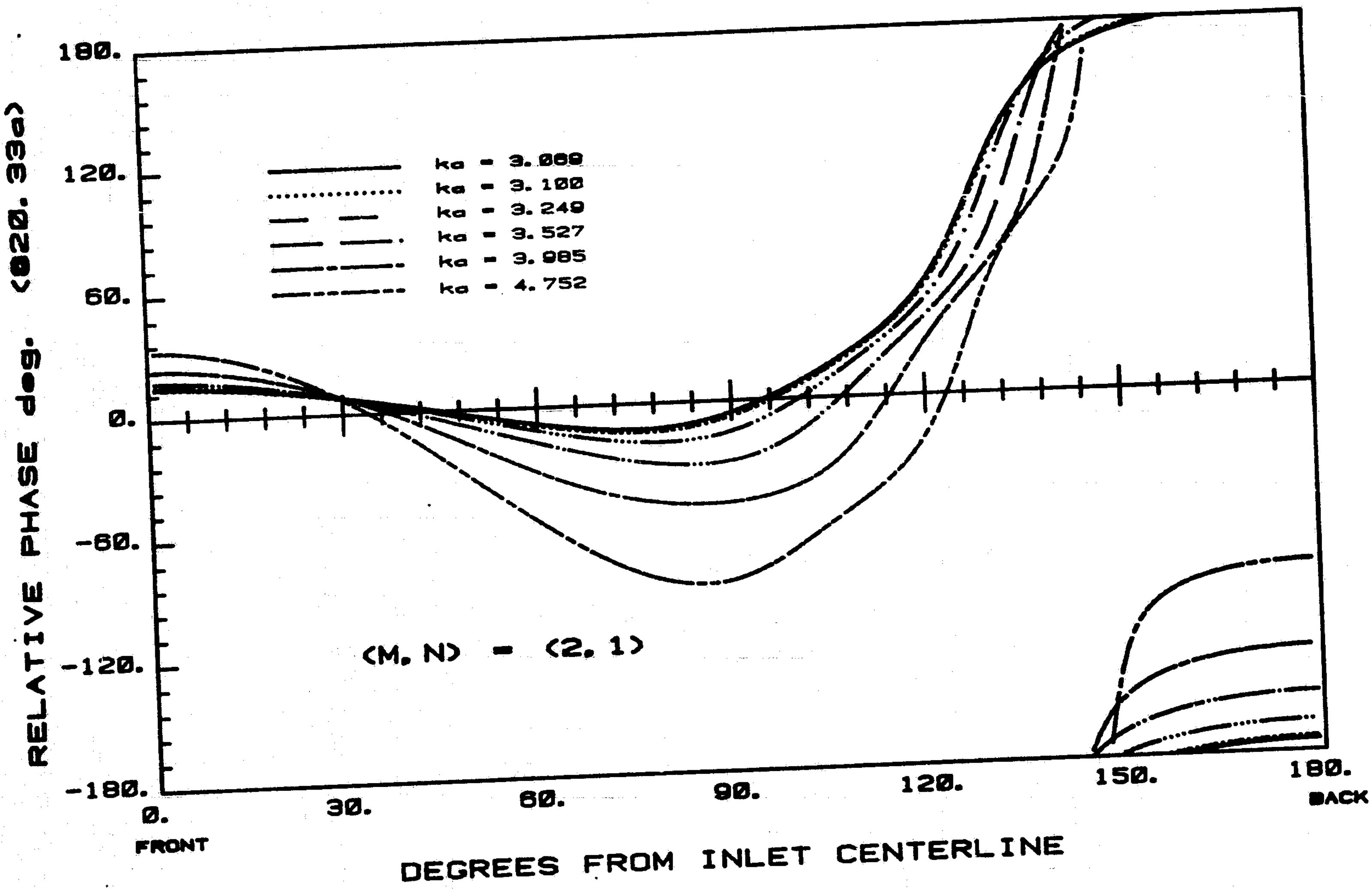


Fig. 7d



LANGLEY BELLMOUTH

Fig. 7e

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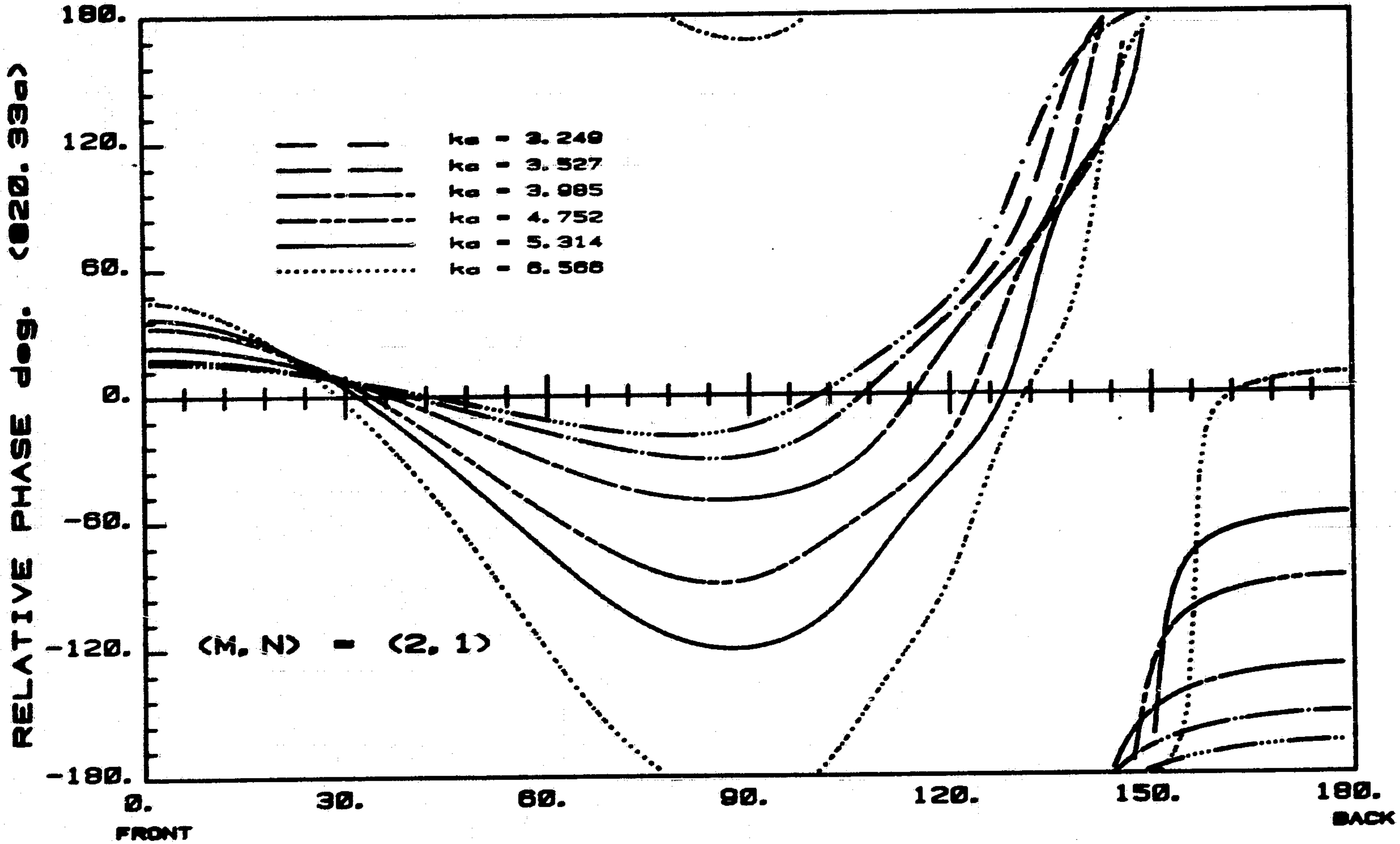


LANGLEY BELLMOUTH

Fig. 7f

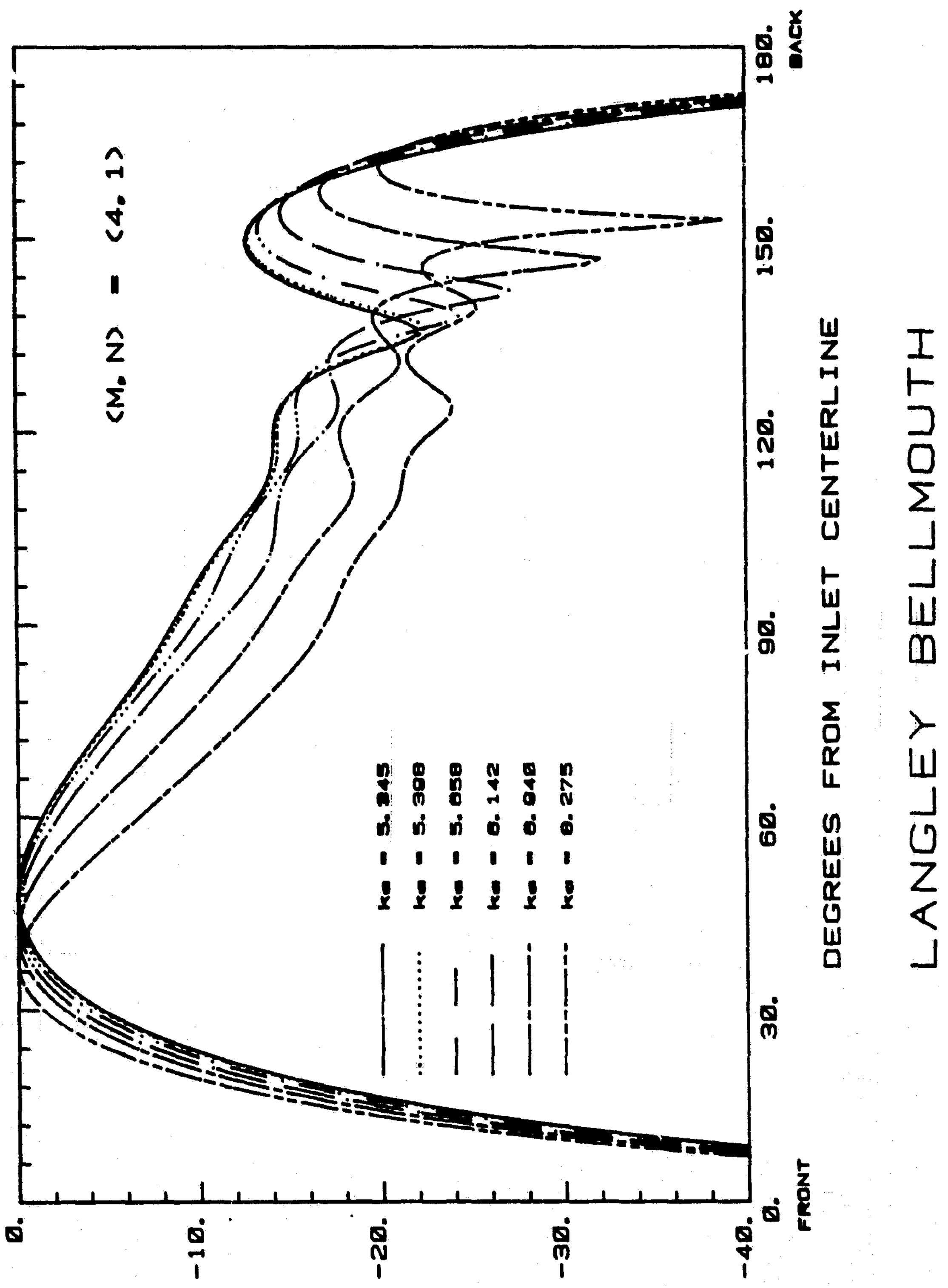

(M, N) = (4, 1)
ka = 5.345
ka = 5.308
ka = 5.658
ka = 6.142
ka = 6.940
ka = 6.275
RELATIVE SPL dB (020.33d)
0.
-10.
-20.
-30.
-40.
0.
FRONT
30.
60.
90.
120.
150.
180.
BACK
DEGREES FROM INLET CENTERLINE
LANGLEY BELLMOUTH

Fig. 8a

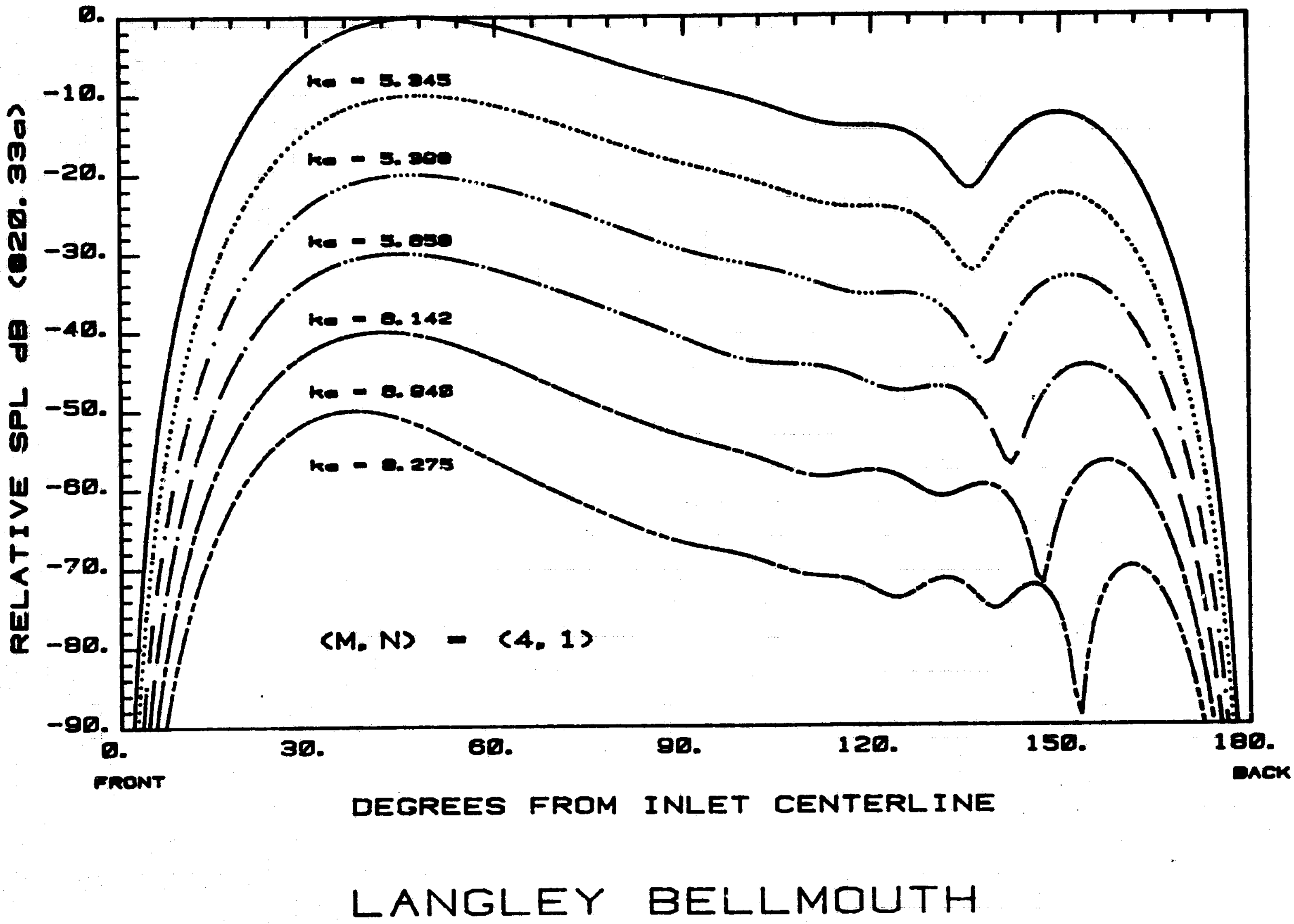
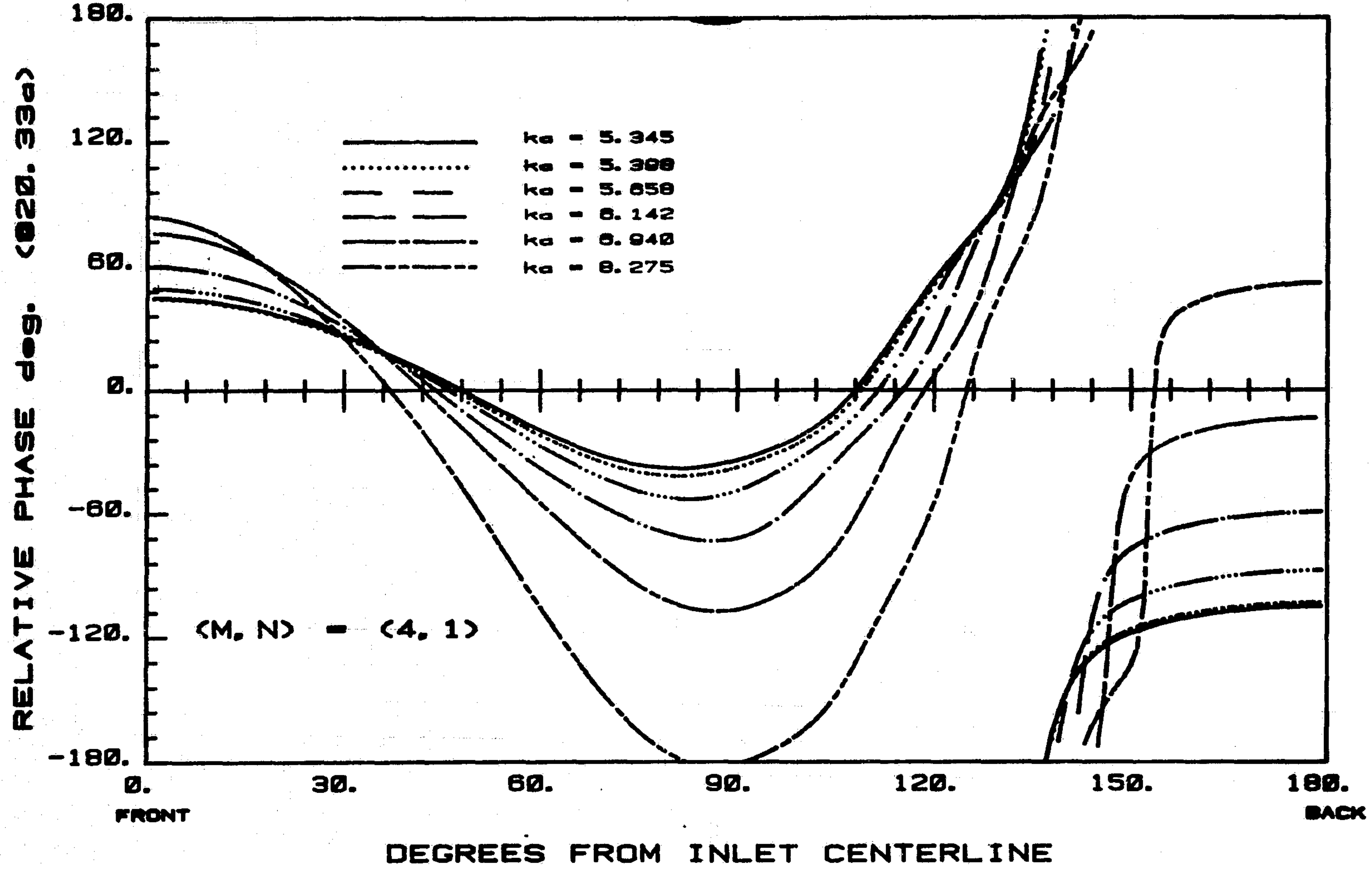

ka = 6.142
ka = 6.275
(M, N) = (4, 1)
RELATIVE SPL dB
0.
-10.
-20.
-30.
-40.
-50.
-60.
-70.
-80.
-90.
0.
30.
60.
90.
120.
150.
180.
FRONT
BACK
DEGREES FROM INLET CENTERLINE
LANGLEY BELLMOUTH

Fig. 8b



LANGLEY BELLMOUTH

Fig. 8c

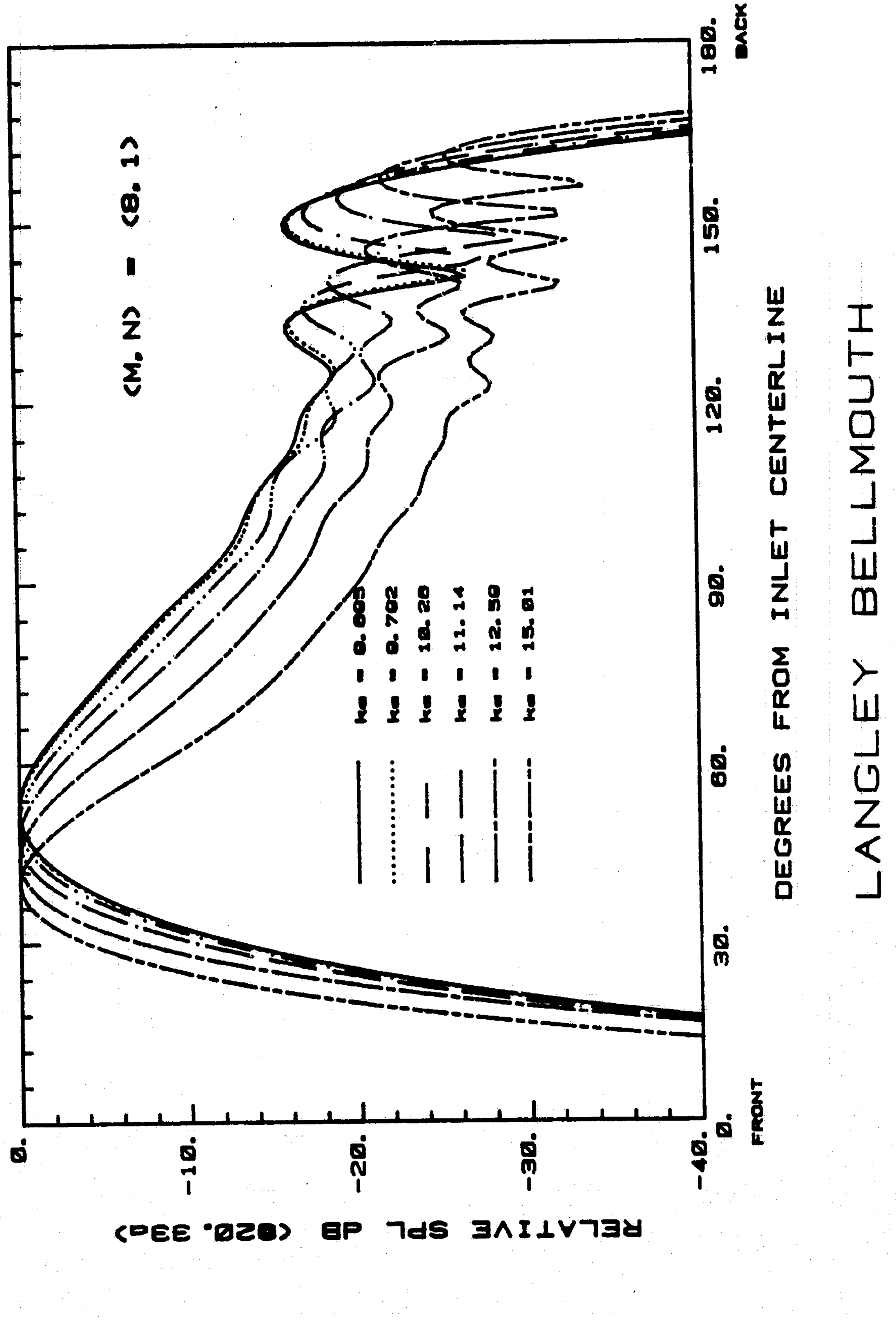
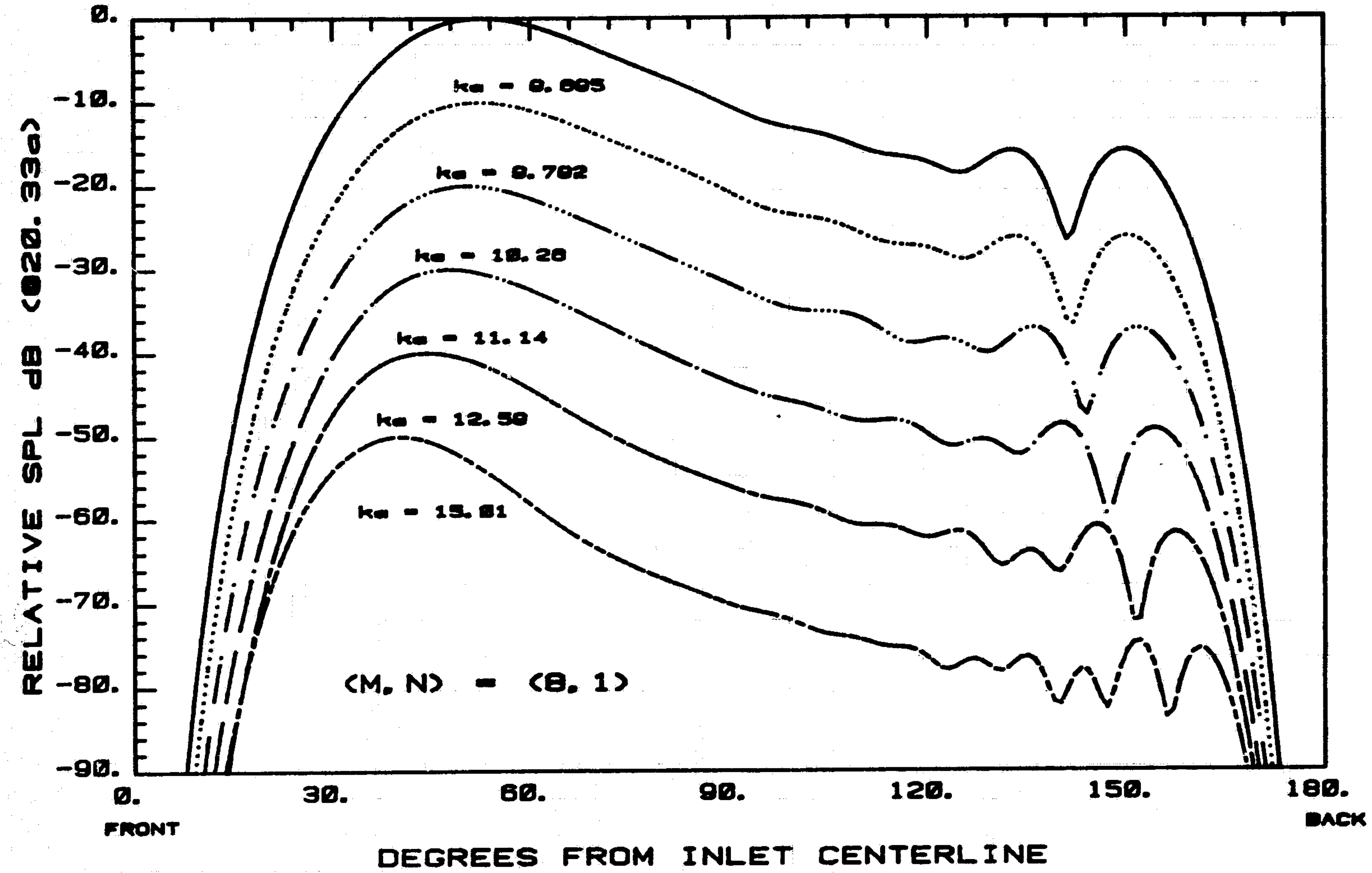
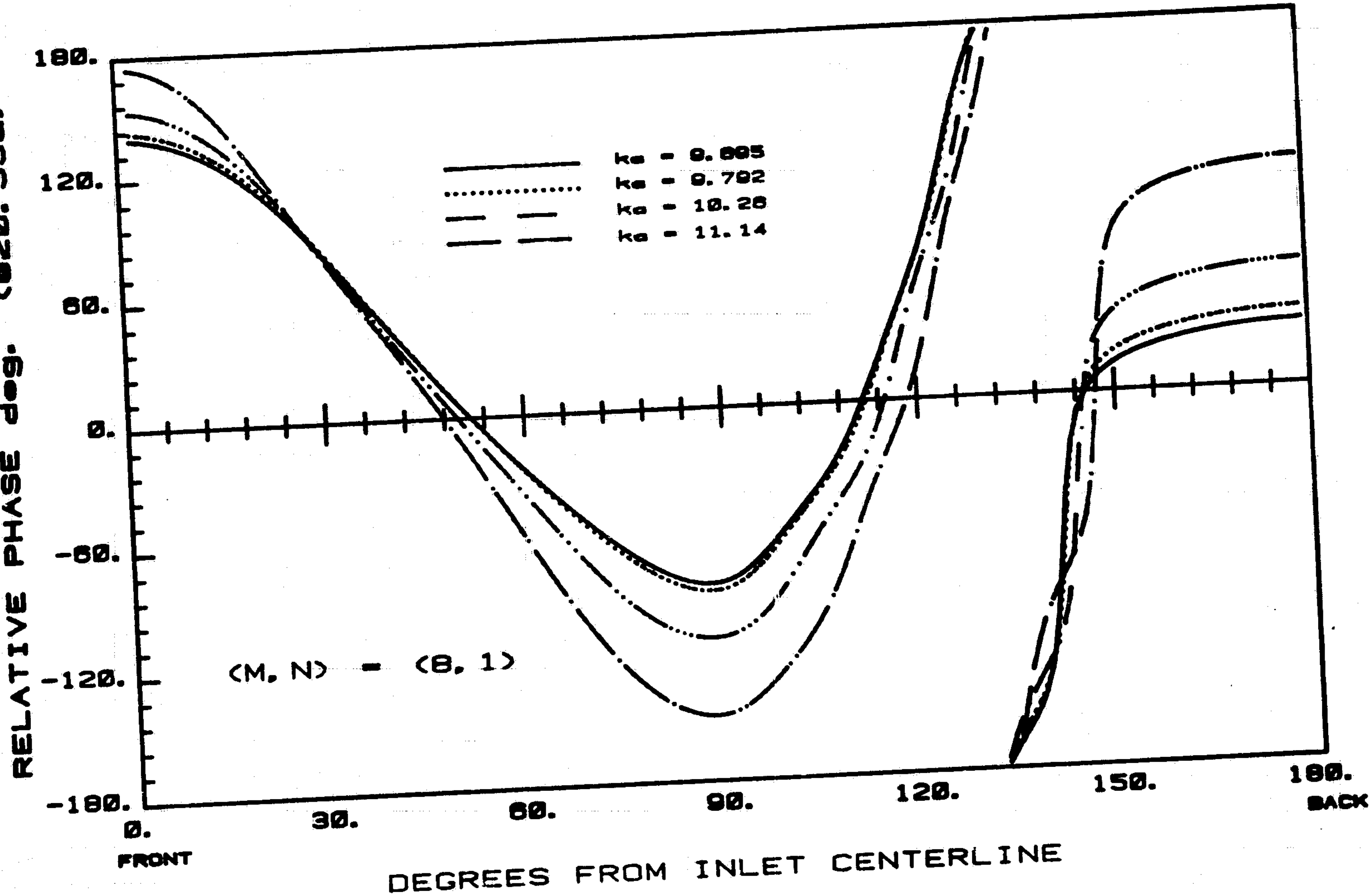

(M, N) = (8, 1)
ka = 9.603
ka = 9.702
ka = 10.20
ka = 11.14
ka = 12.50
ka = 15.01
DEGREES FROM INLET CENTERLINE
FRONT
BACK
0.
30.
60.
90.
120.
150.
180.
RELATIVE SPL dB
0.
-10.
-20.
-30.
-40.
LANGLEY BELLMOUTH

Fig. 9a



LANGLEY BELLMOUTH

Fig. 9b



LANGLEY BELLMOUTH

Fig. 9c

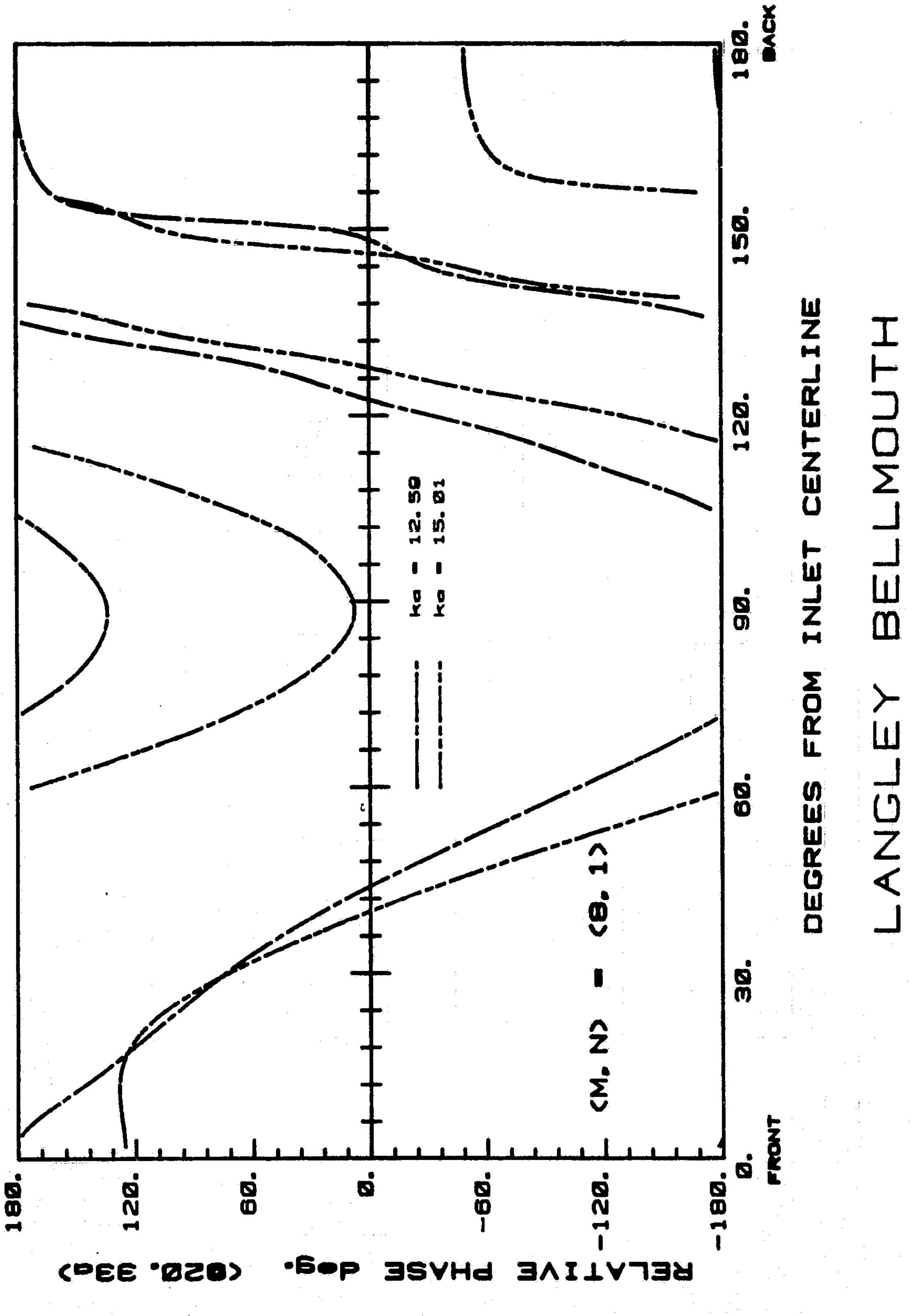
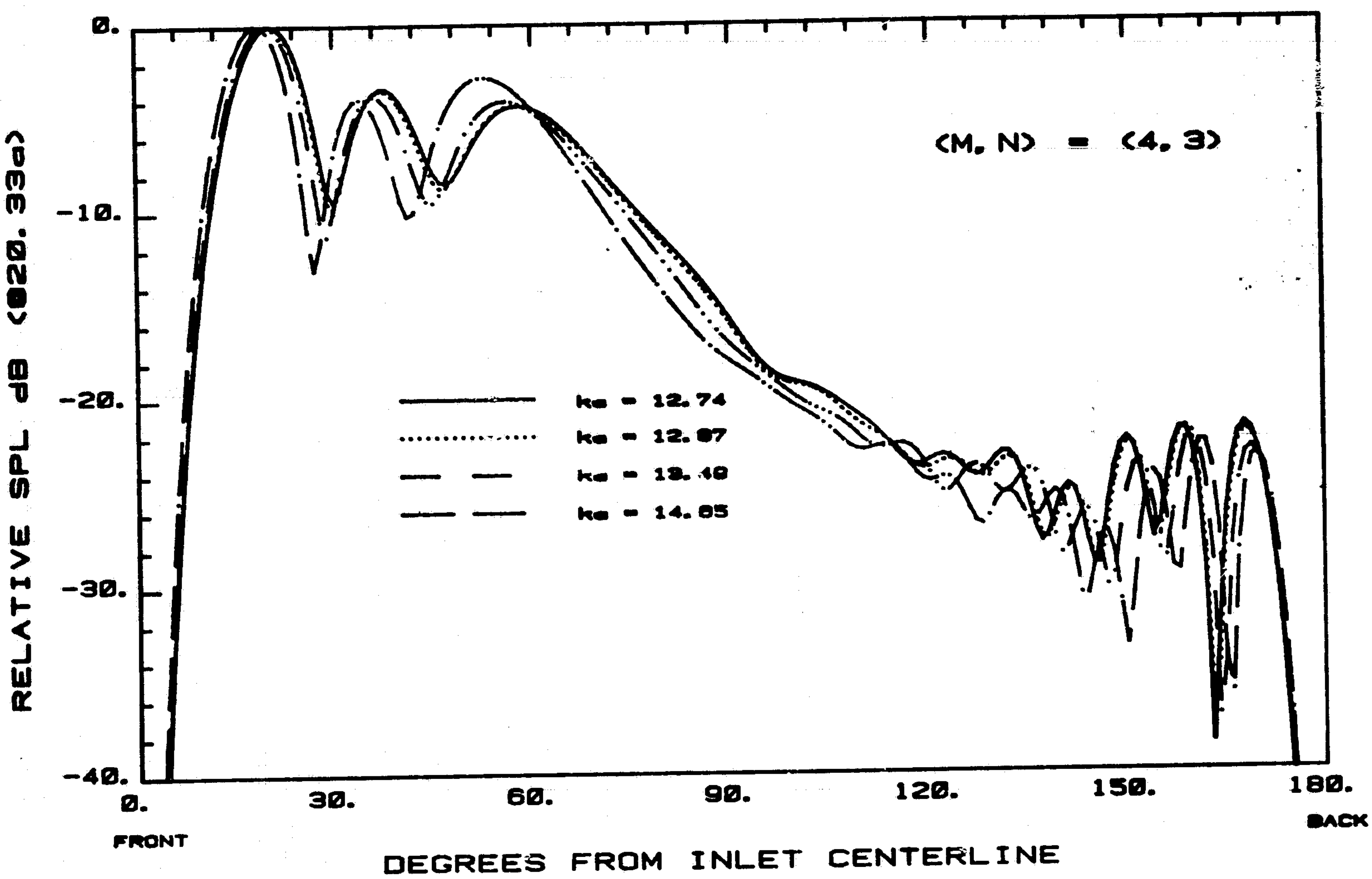
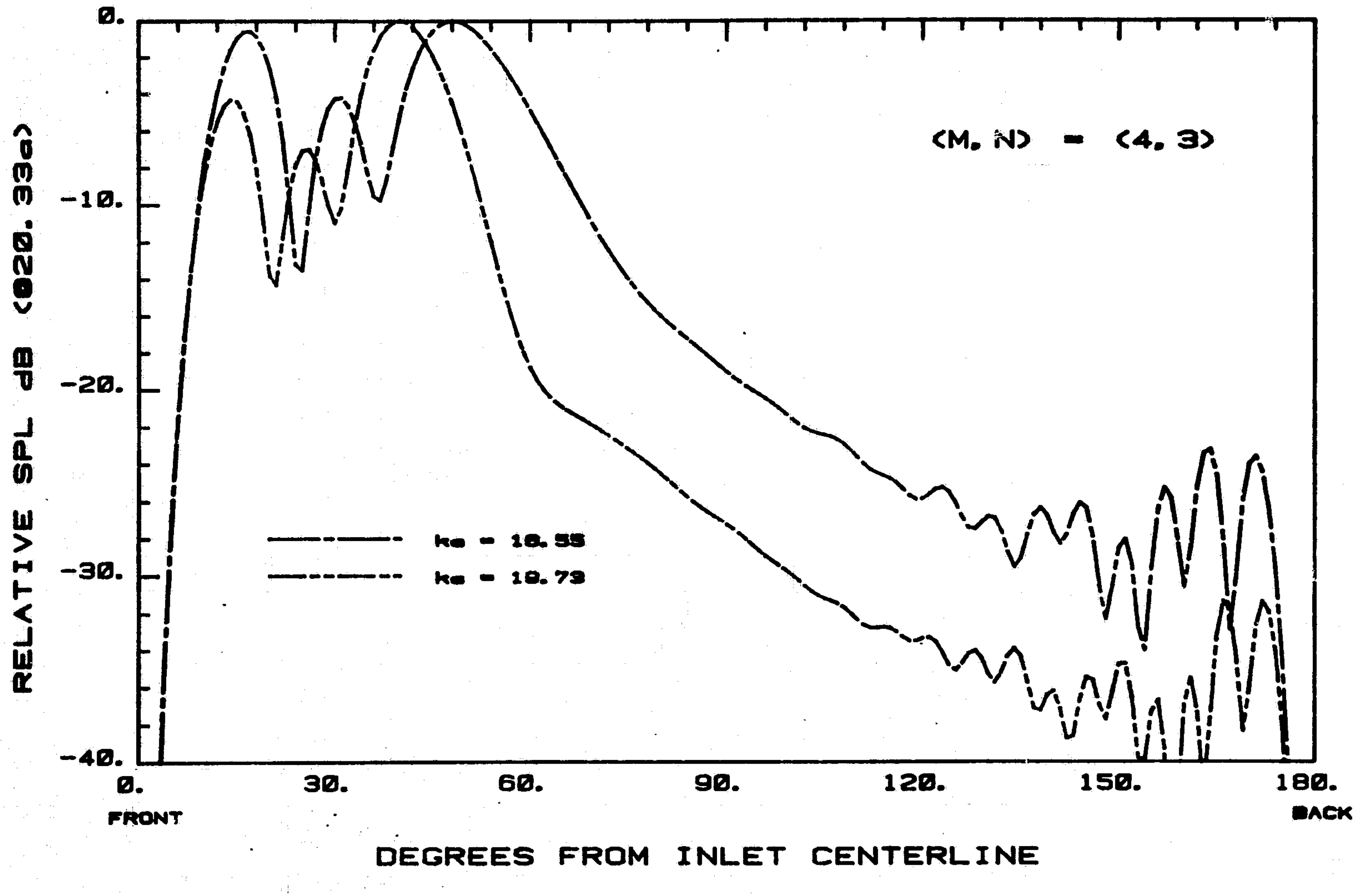

RELATIVE PHASE deg. (020, 33d)
180.
120.
60.
0.
-60.
-120.
-180.
0.
FRONT
30.
60.
90.
120.
150.
180.
BACK
DEGREES FROM INLET CENTERLINE
(M, N) = (8, 1)
ka = 12.50
ka = 15.01
LANGLEY BELLMOUTH

Fig. 9d



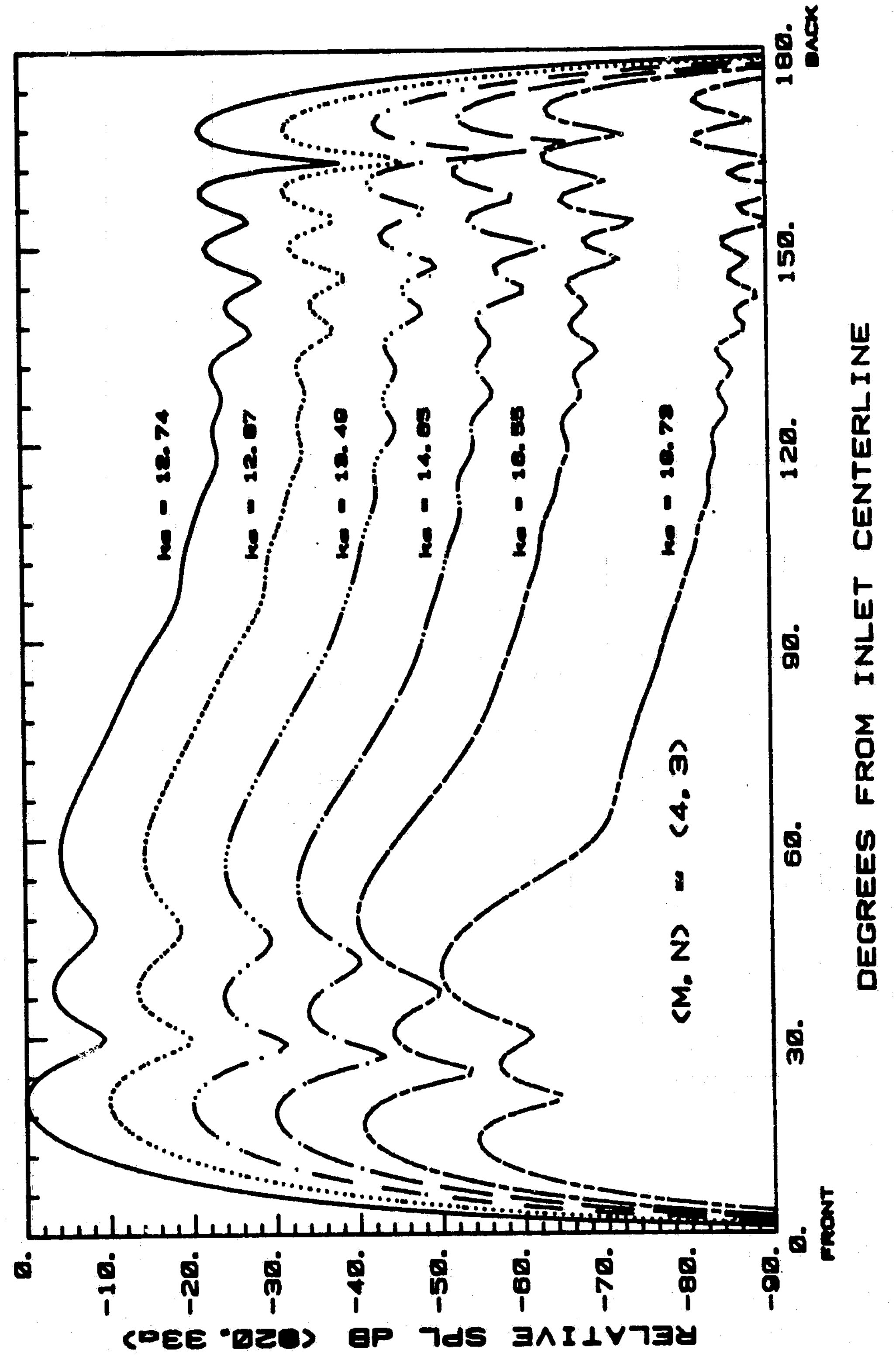
LANGLEY BELLMOUTH

Fig. 10a



LANGLEY BELLMOUTH

Fig. 10b



LANGLEY BELLMOUTH

Fig. 10c

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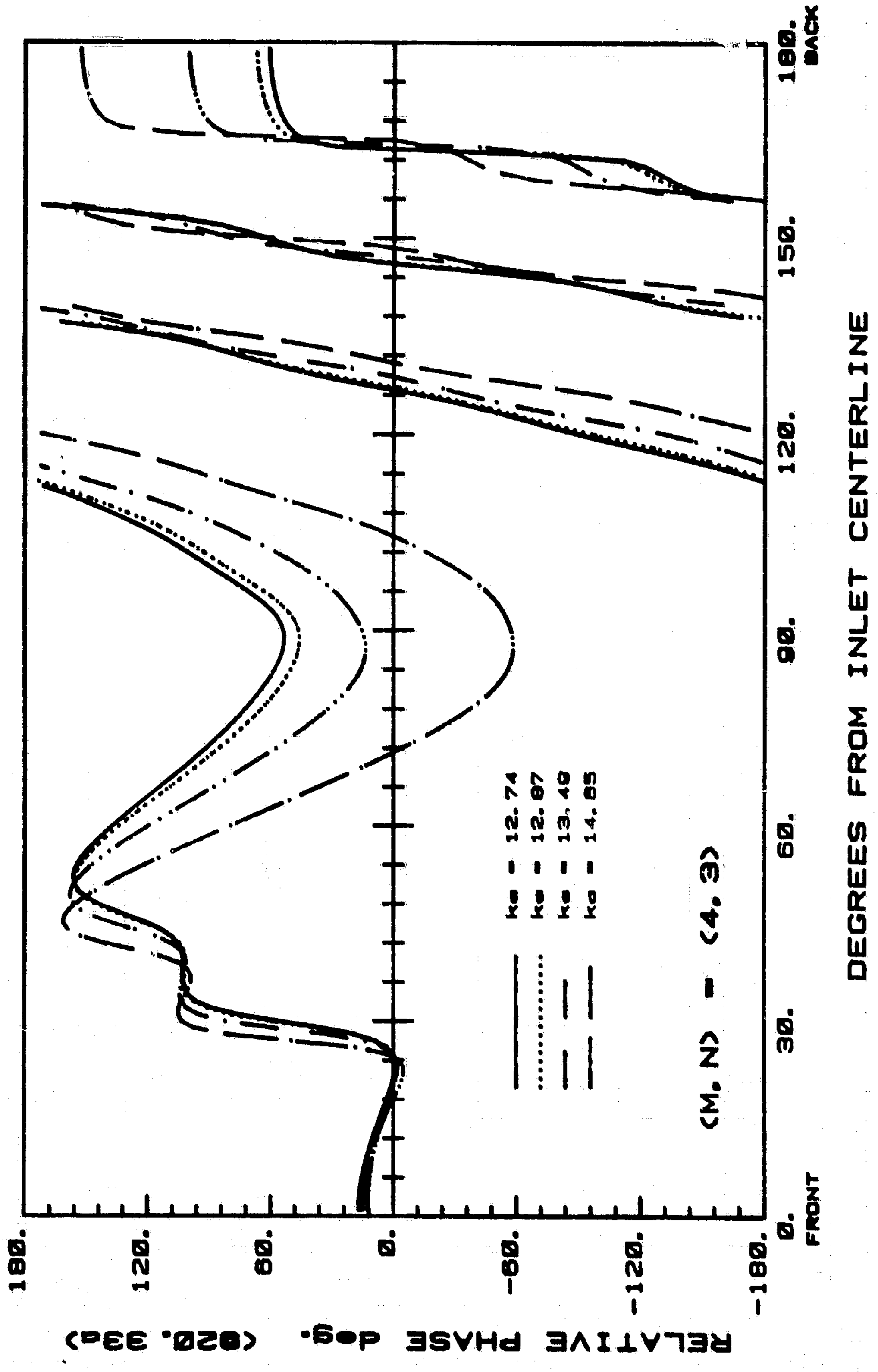
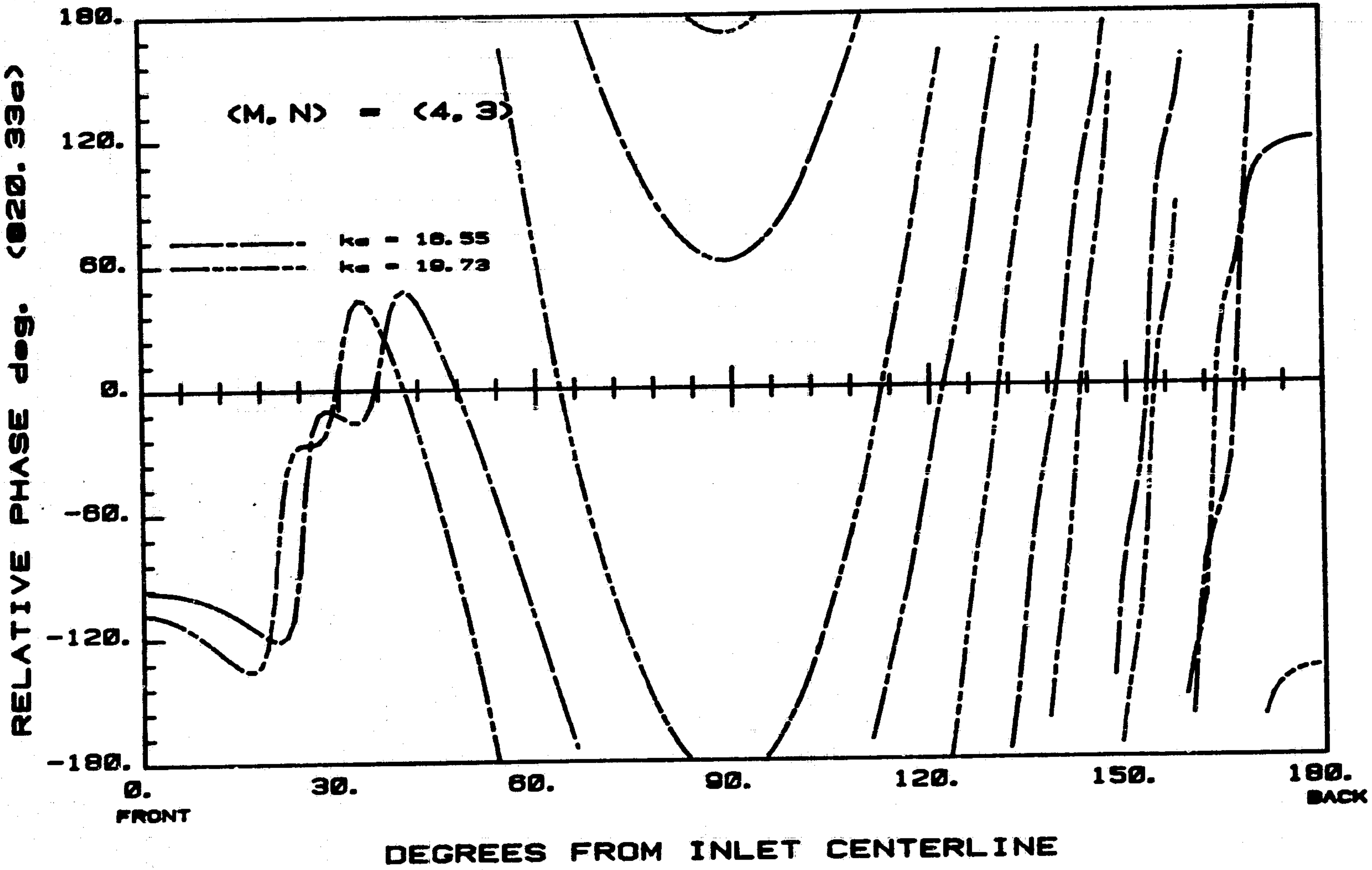


LANGLEY BELLMOUTH

Fig. 10d



LANGLEY BELLMOUTH

Fig. 10e

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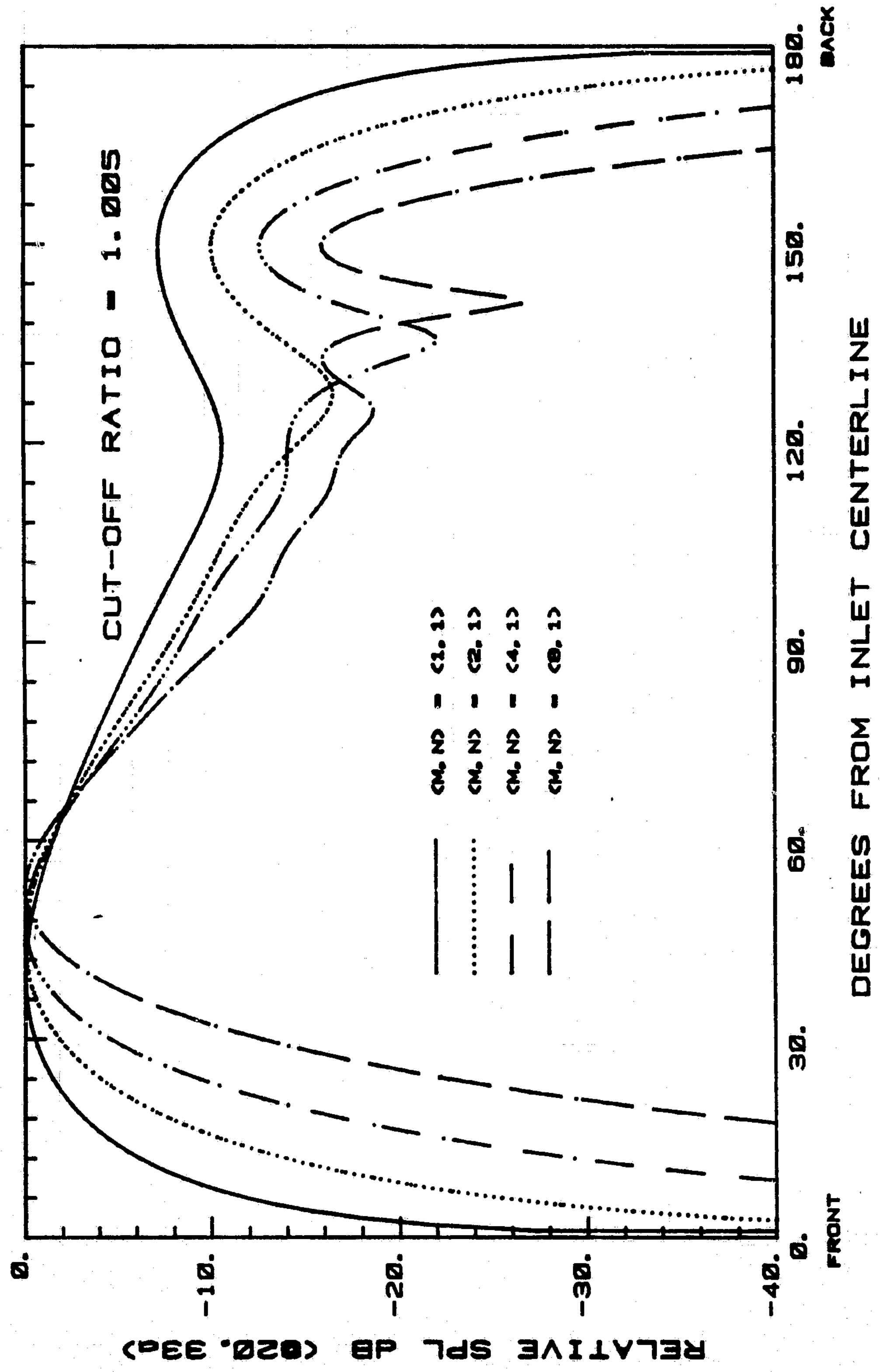

LANGLEY BELLMOUTH

Fig. 11a

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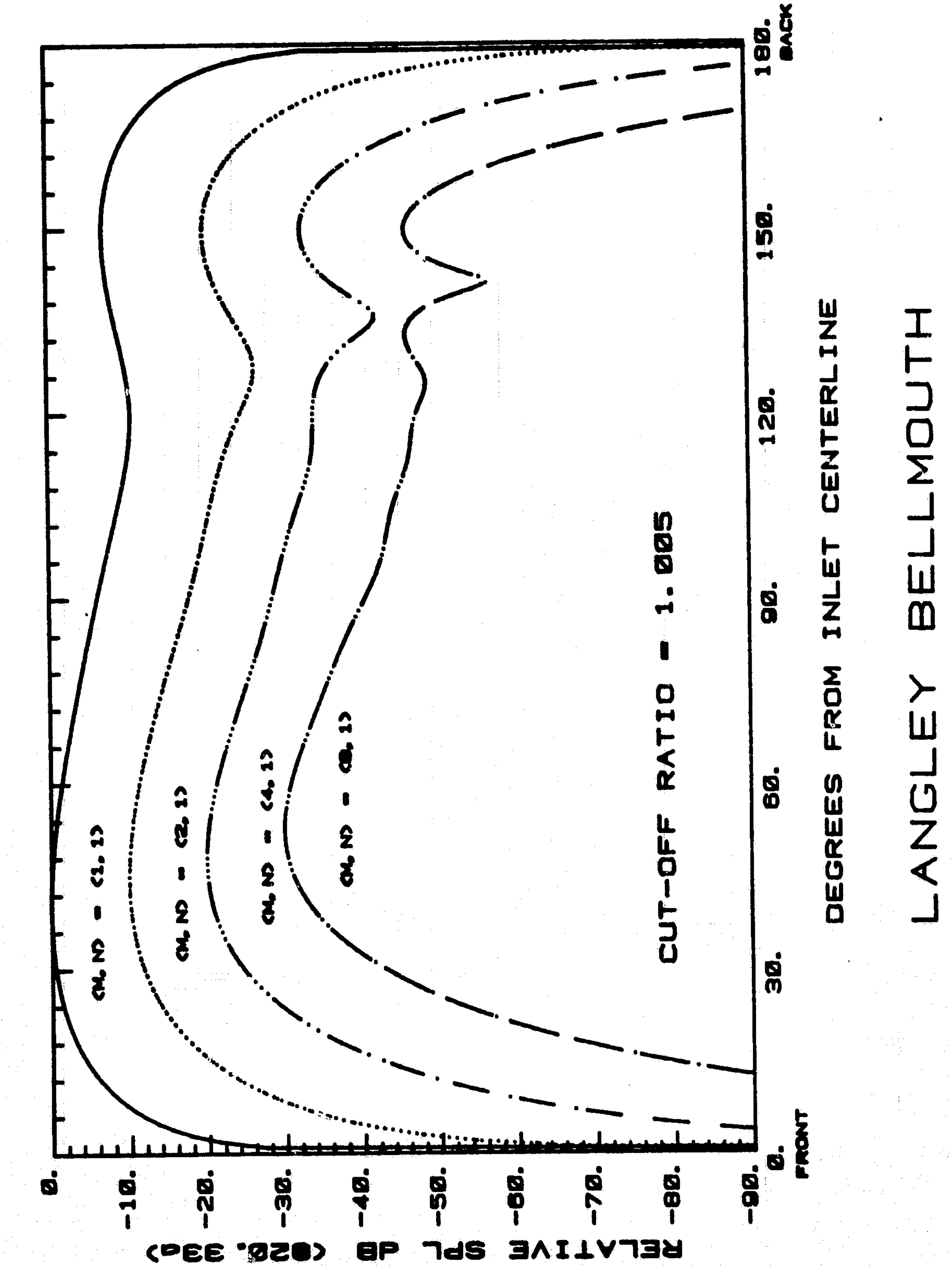
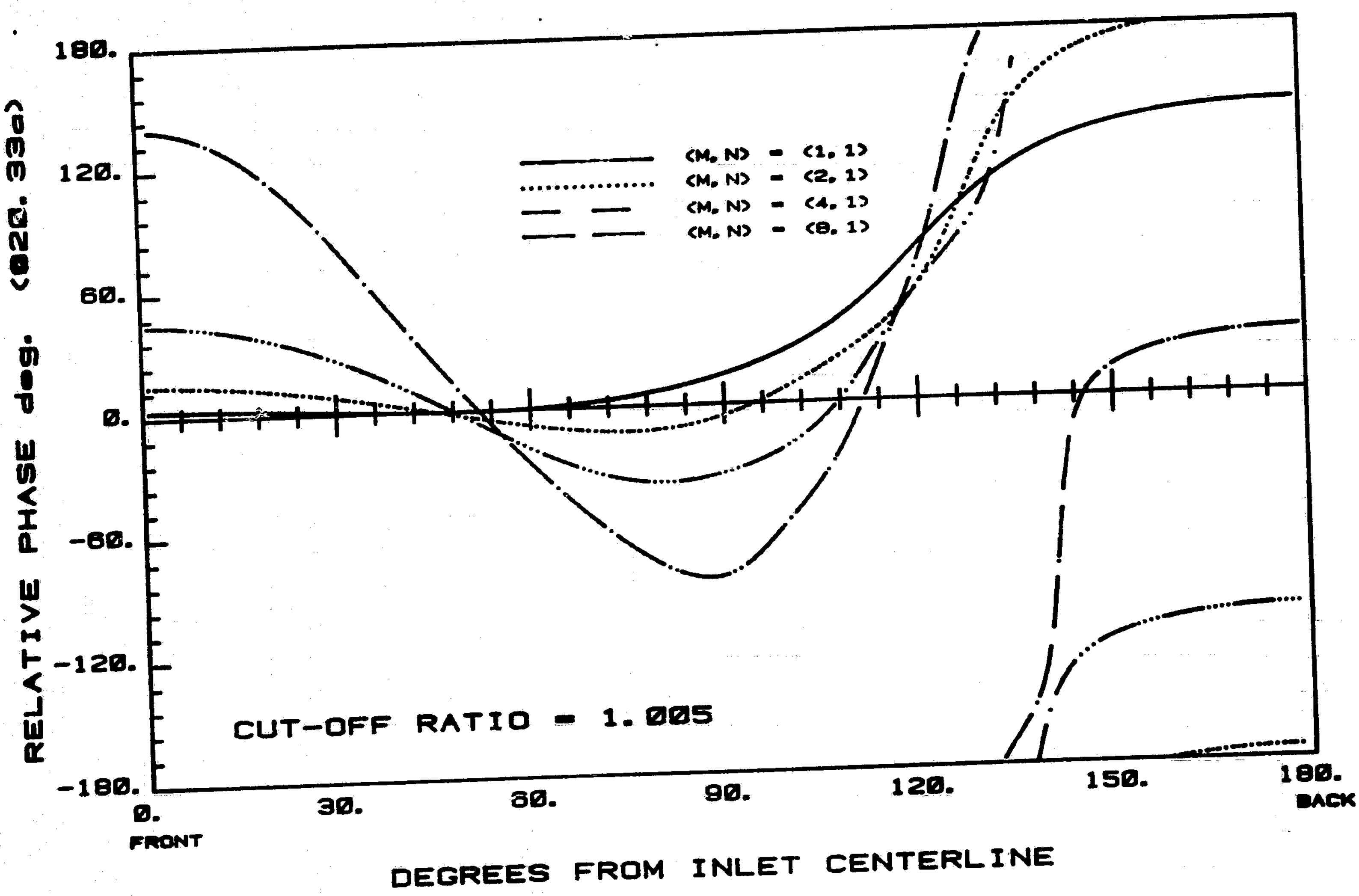


Fig. 11b



LANGLEY BELLMOUTH

Fig. 11c

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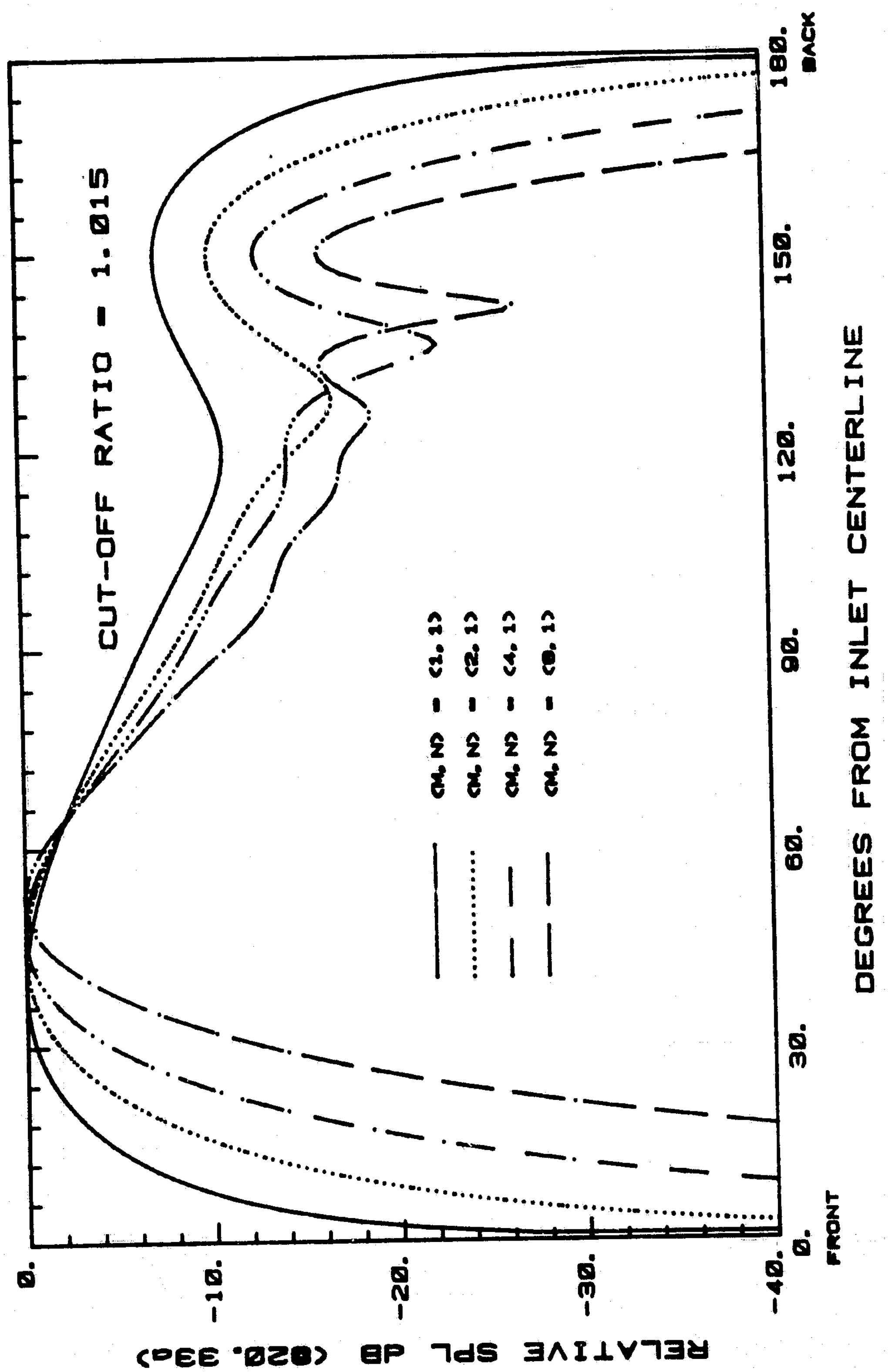
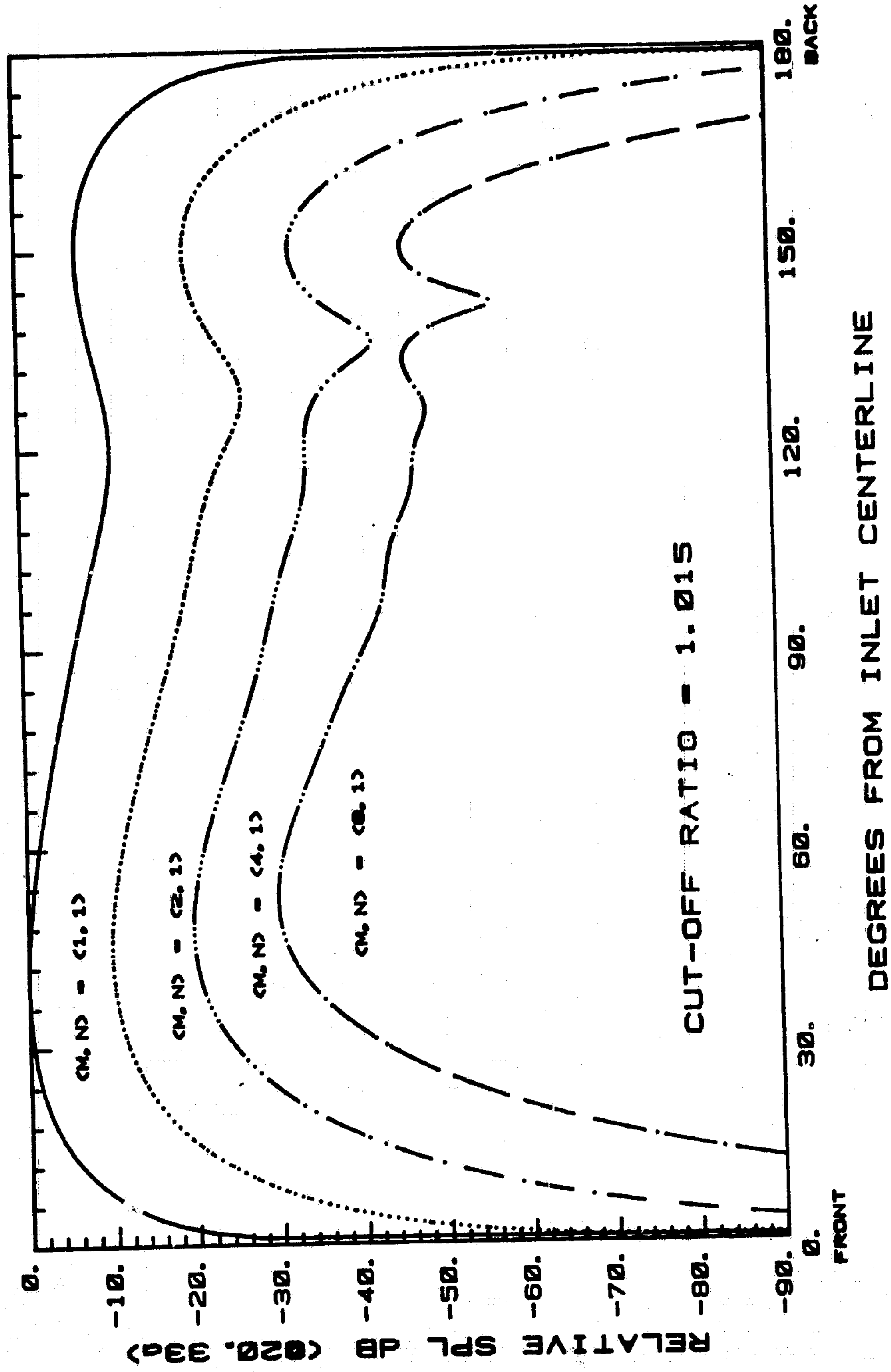


LANGLEY BELLMOUTH

Fig. 12a



LANGLEY BELLMOUTH

Fig. 12b

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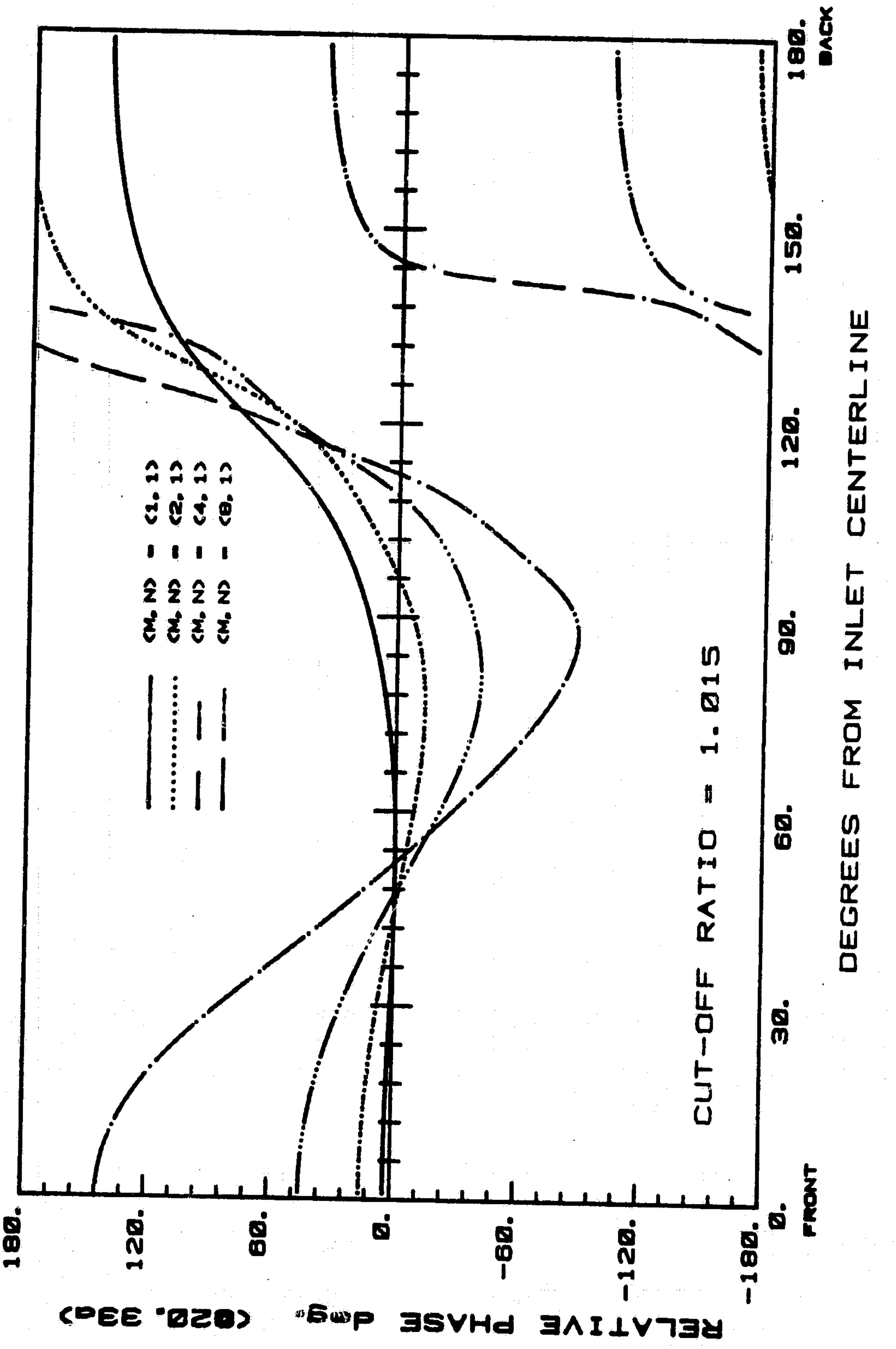

LANGLEY BELLMOUTH

Fig. 12c

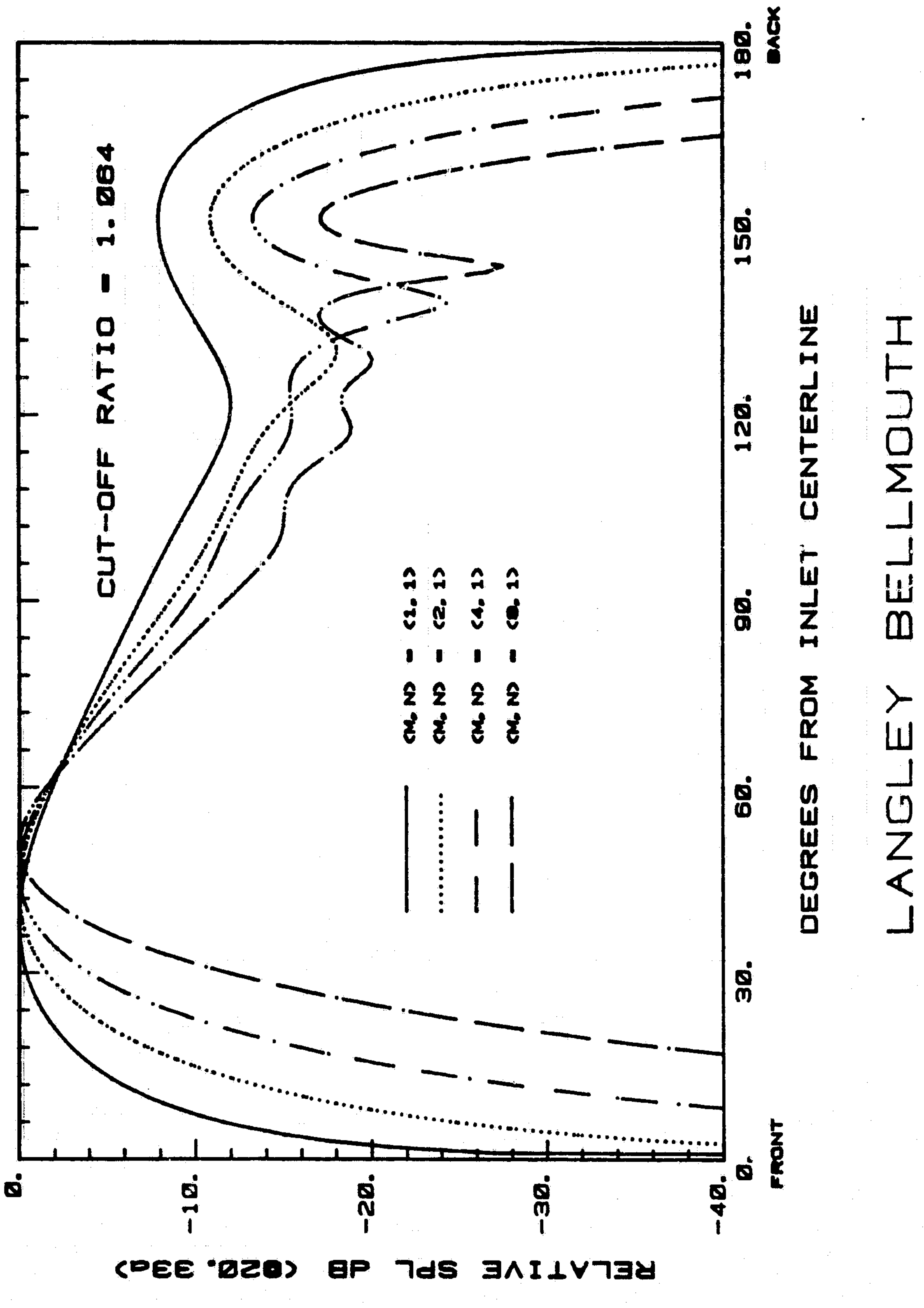
CUT-OFF RATIO = 1.064
(M,N) = (1,1)
(M,N) = (2,1)
(M,N) = (4,1)
(M,N) = (8,1)
0.
-10.
-20.
-30.
-40.
RELATIVE SPL dB
0.
30.
60.
90.
120.
150.
180.
FRONT
BACK
DEGREES FROM INLET CENTERLINE
LANGLEY BELLMOUTH

Fig. 13a

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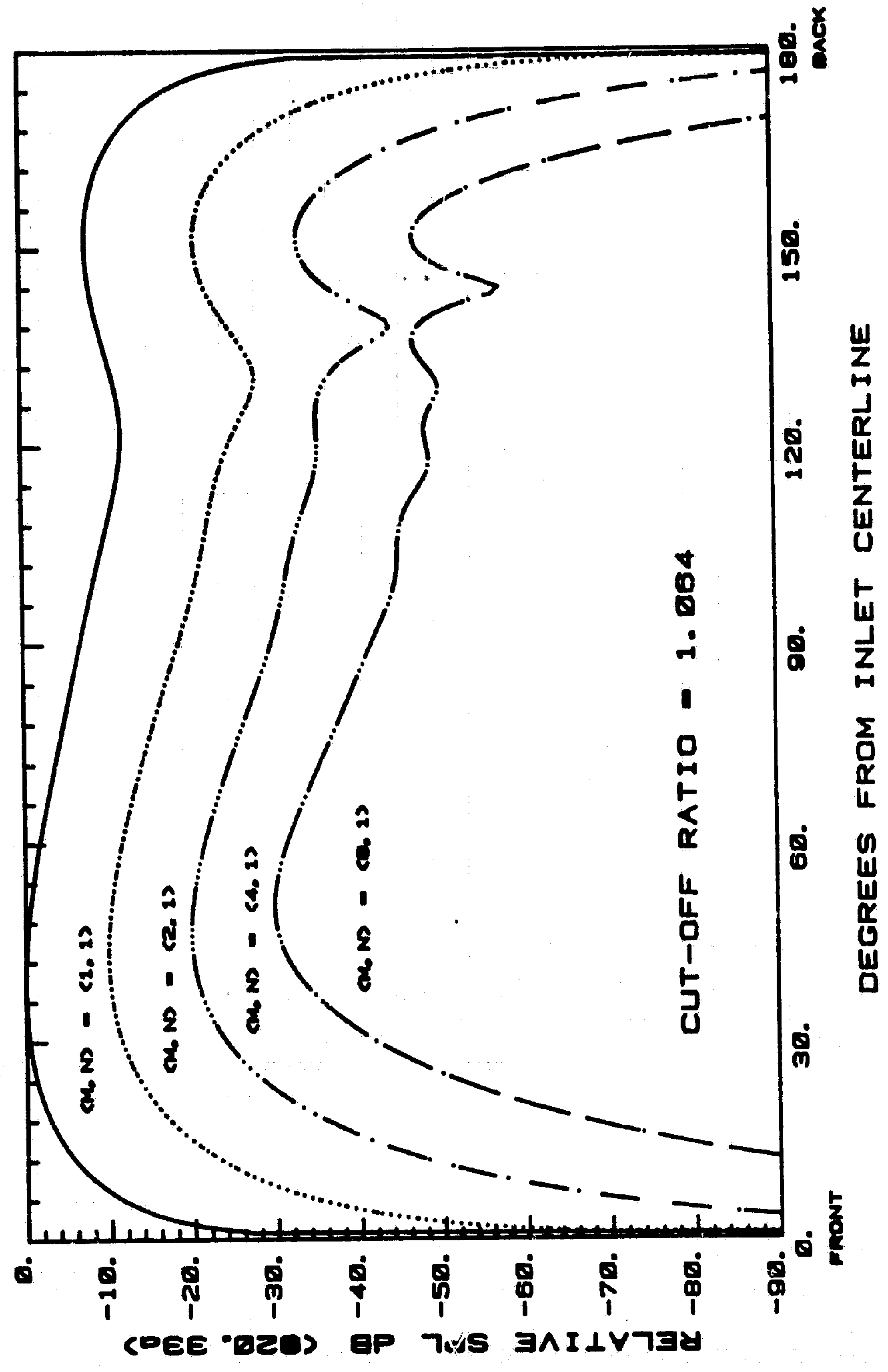

LANGLEY BELLMOUTH

Fig. 13b

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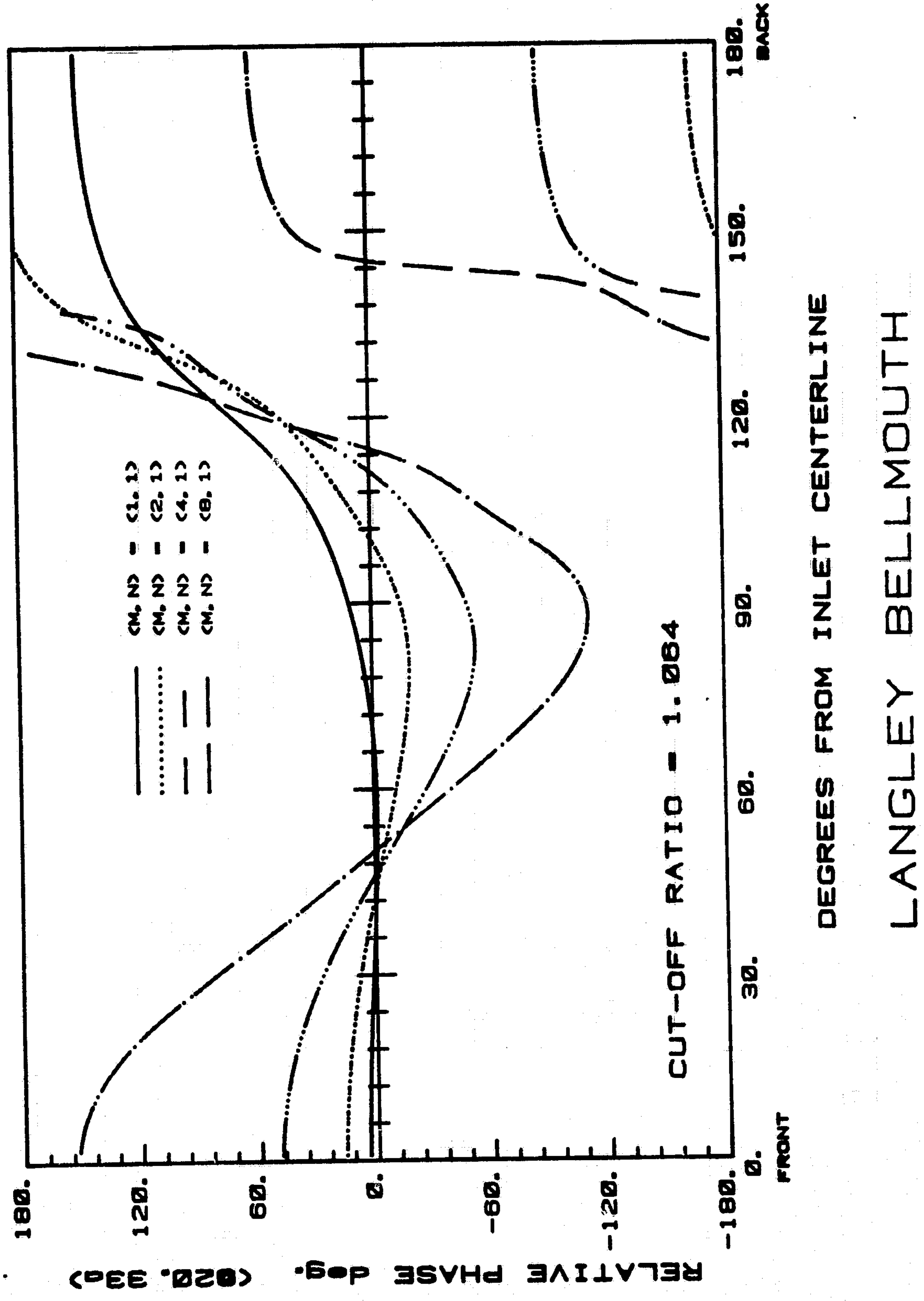

Fig. 13c

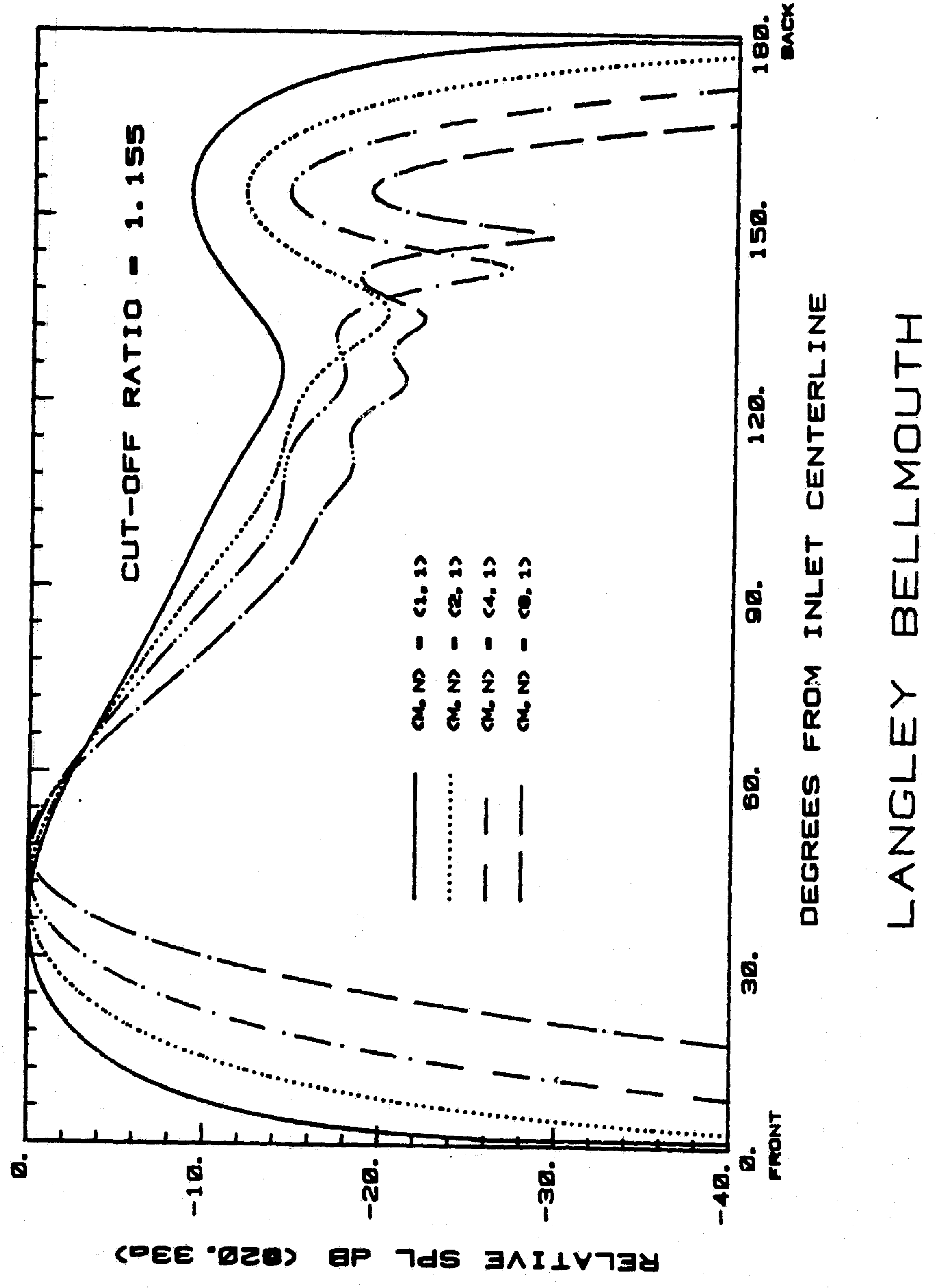
CUT-OFF RATIO = 1.155
(M, N) = (1, 1)
(M, N) = (2, 1)
(M, N) = (4, 1)
(M, N) = (8, 1)
0.
-10.
-20.
-30.
-40.
RELATIVE SPL dB (020. 33d)
0. FRONT
30.
60.
90.
120.
150.
180. BACK
DEGREES FROM INLET CENTERLINE
LANGLEY BELLMOUTH

Fig. 14a

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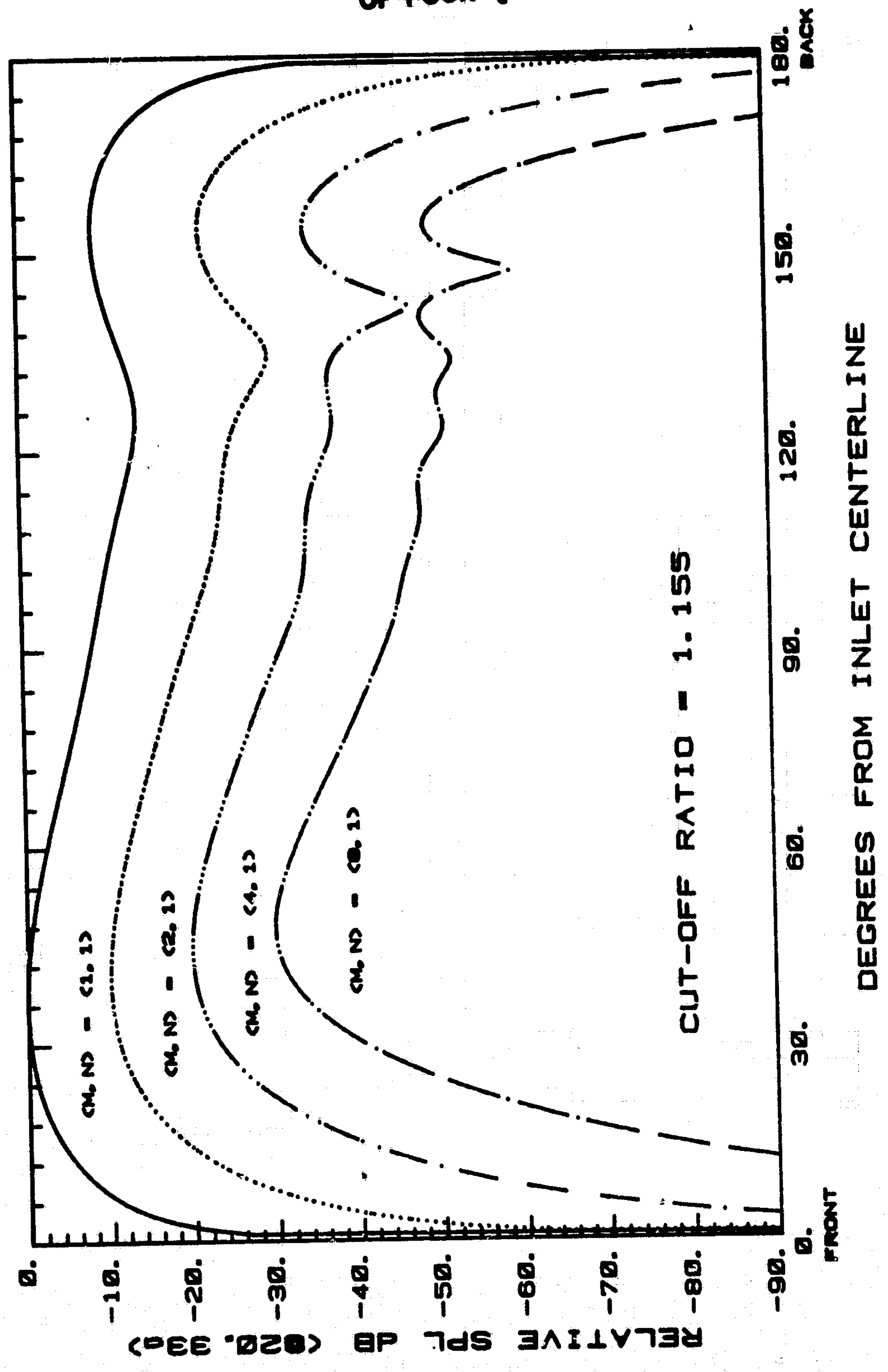

LANGLEY BELLMOUTH

Fig. 14b

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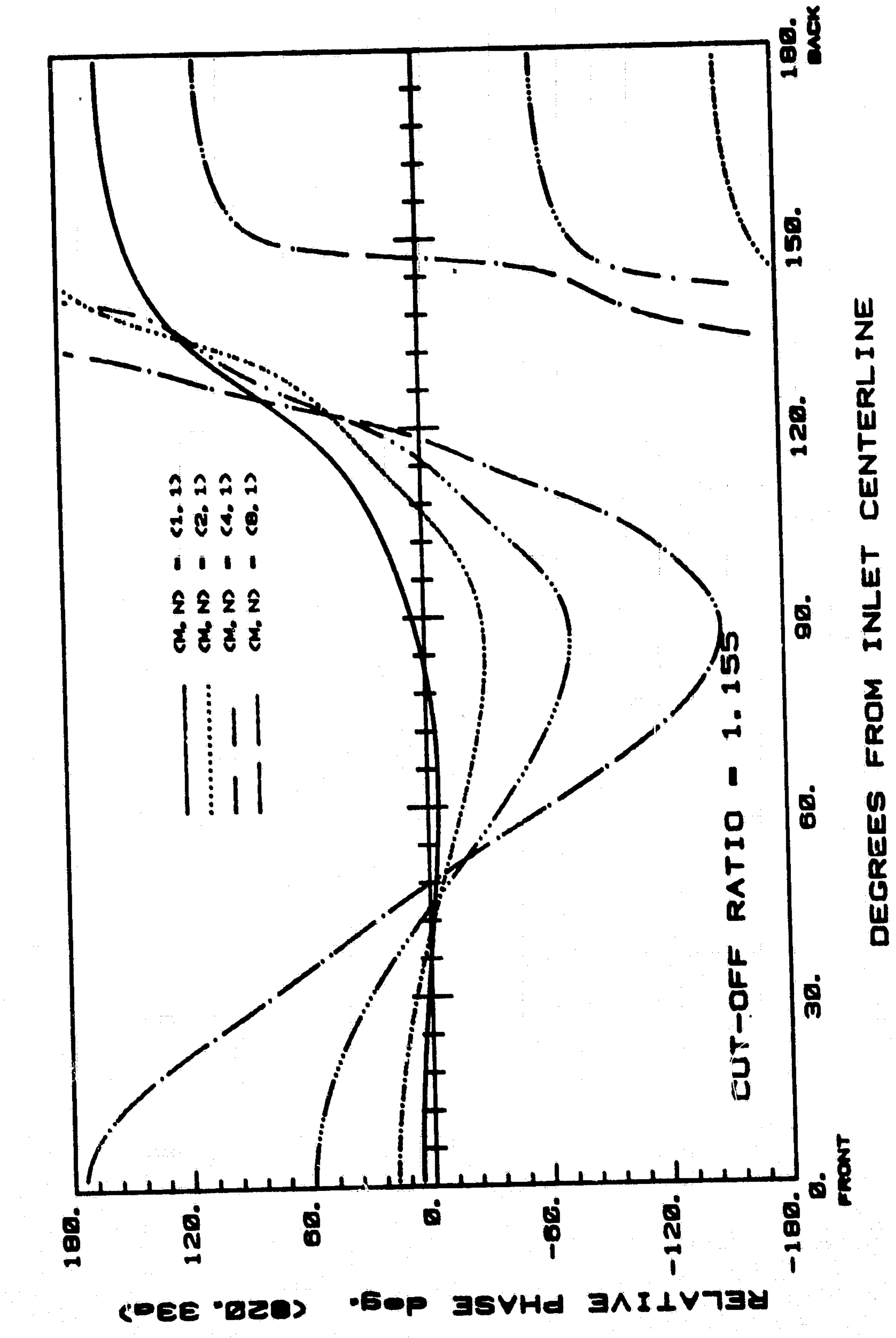

LANGLEY BELLMOUTH

Fig. 14c

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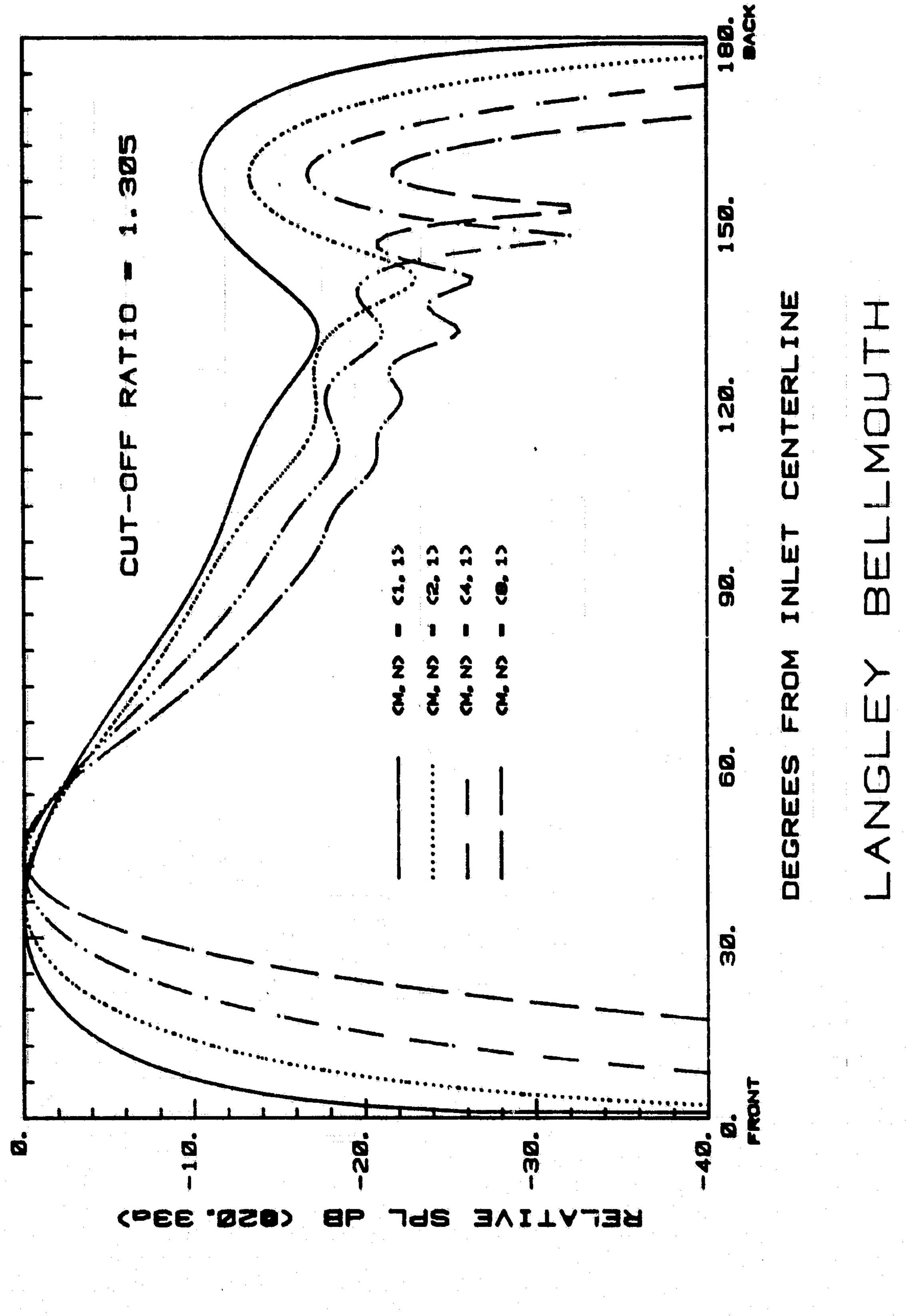
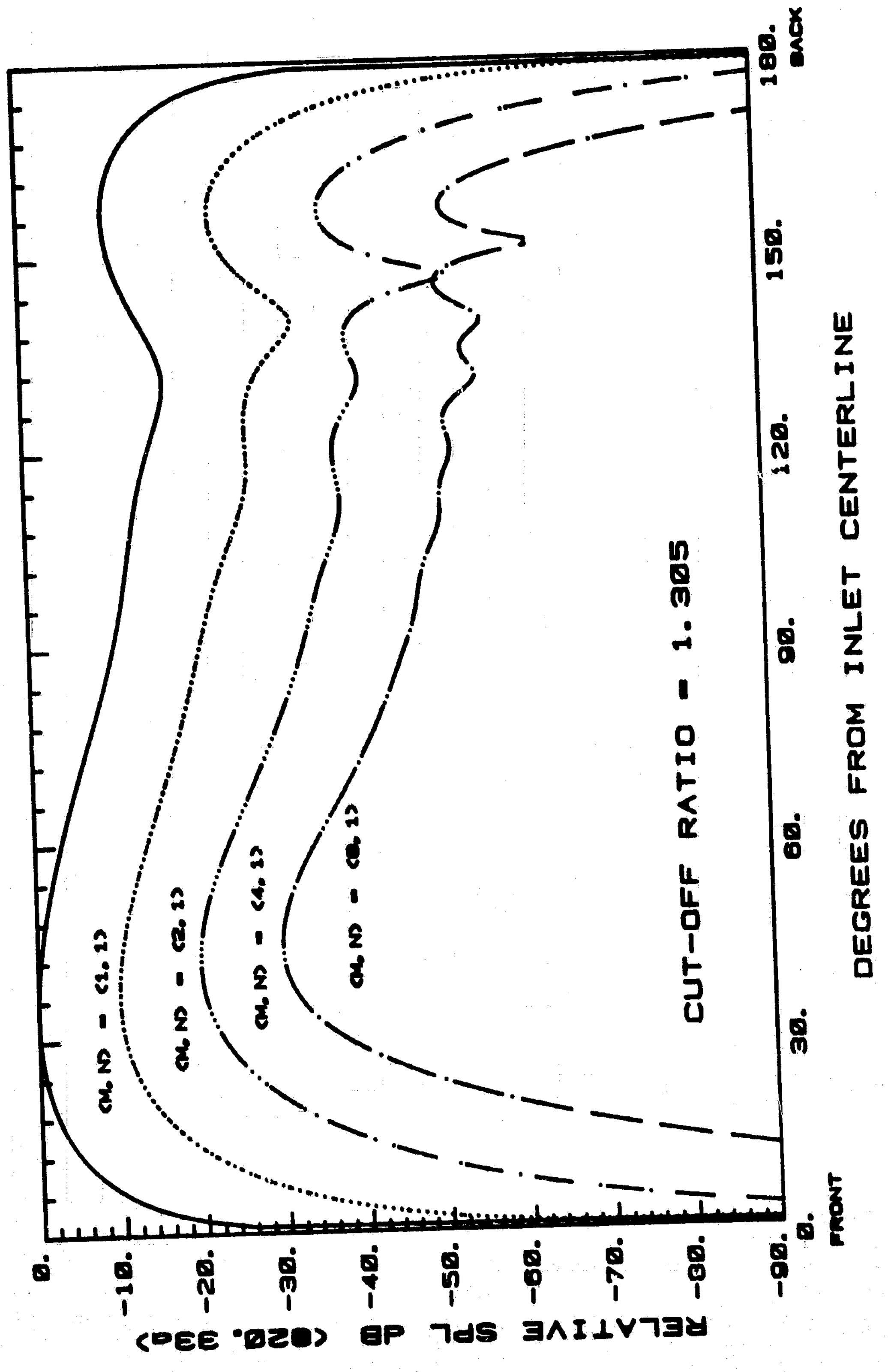


Fig. 15a



LANGLEY BELLMOUTH

Fig. 15b

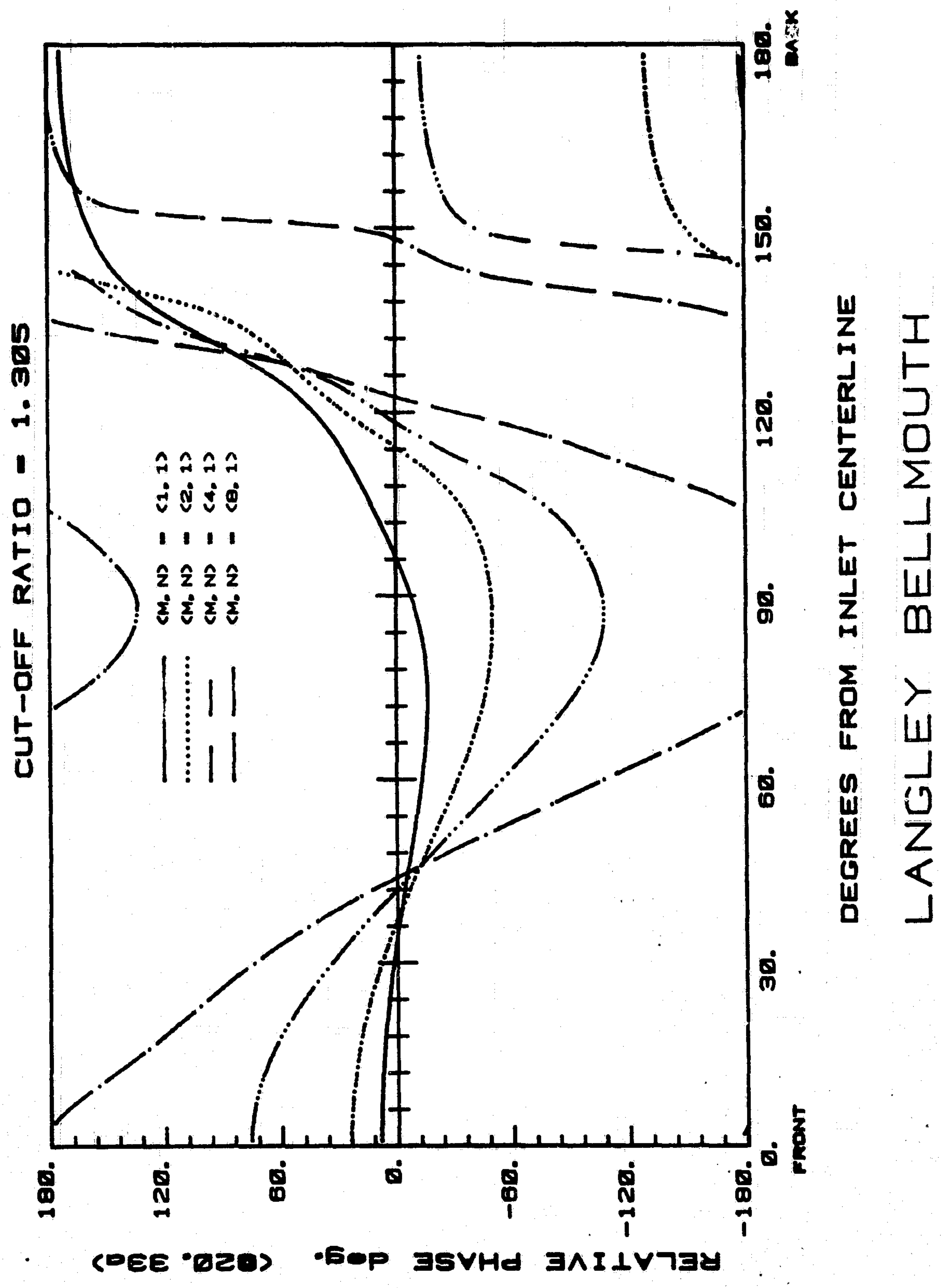

CUT-OFF RATIO = 1.305
(M, N) = (1, 1)
(M, N) = (2, 1)
(M, N) = (4, 1)
(M, N) = (8, 1)
RELATIVE PHASE deg. (020. 33d)
180.
120.
60.
0.
-60.
-120.
-180.
0.
30.
60.
90.
120.
150.
180.
FRONT
BACK
DEGREES FROM INLET CENTERLINE
LANGLEY BELLMOUTH

Fig. 15c

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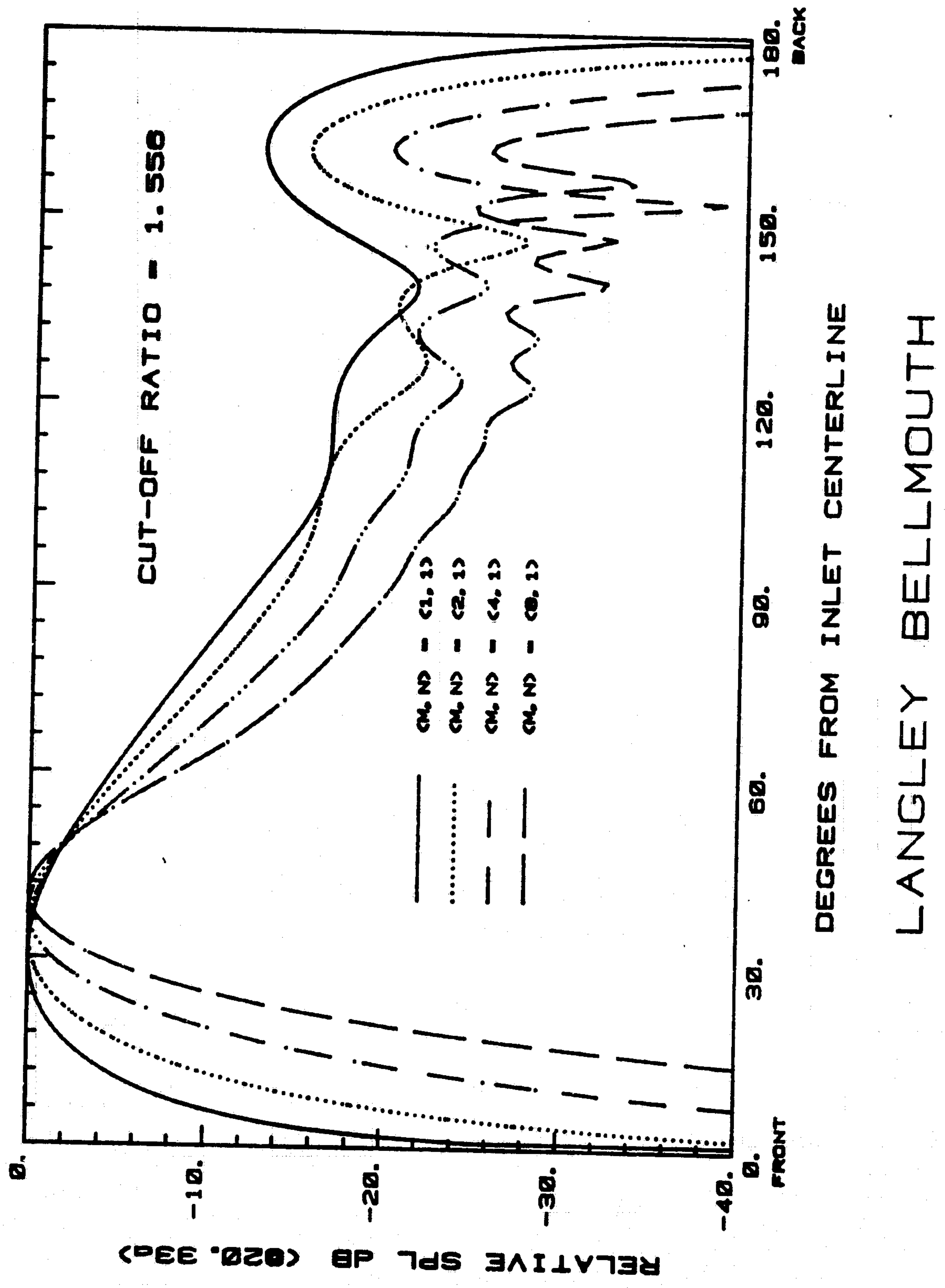
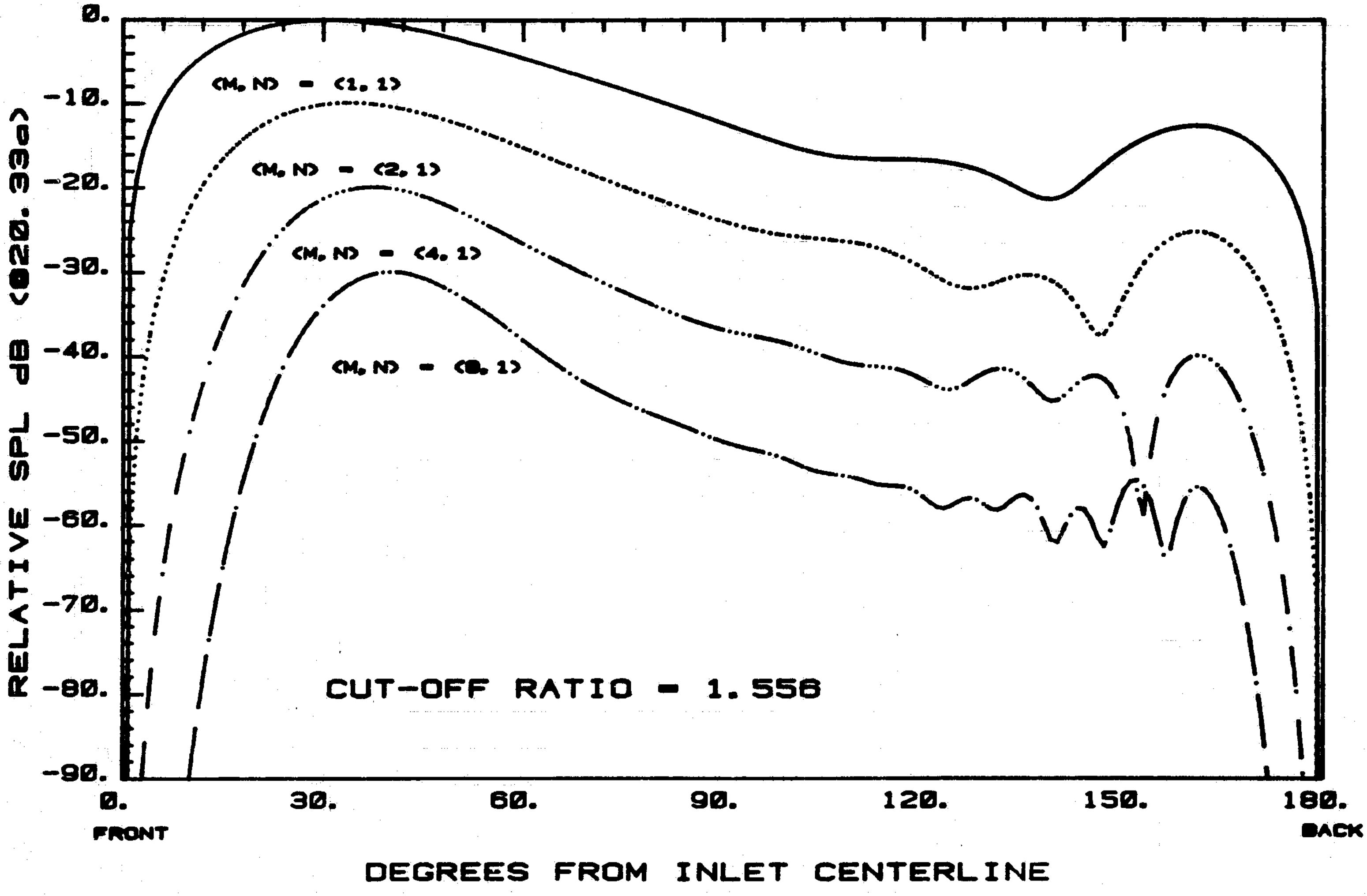
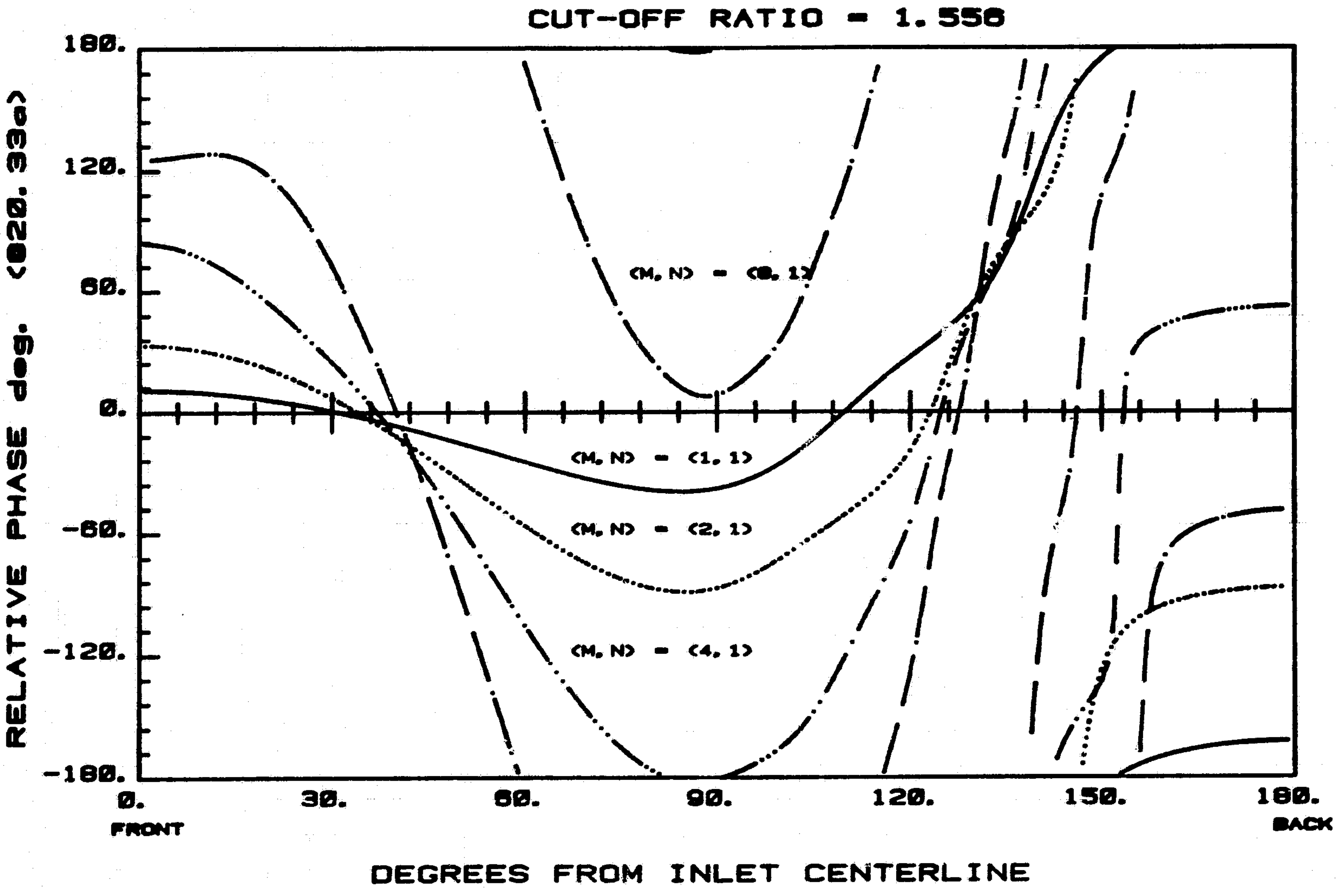


Fig. 16a



LANGLEY BELLMOUTH

Fig. 16b



LANGLEY BELLMOUTH

Fig. 16c

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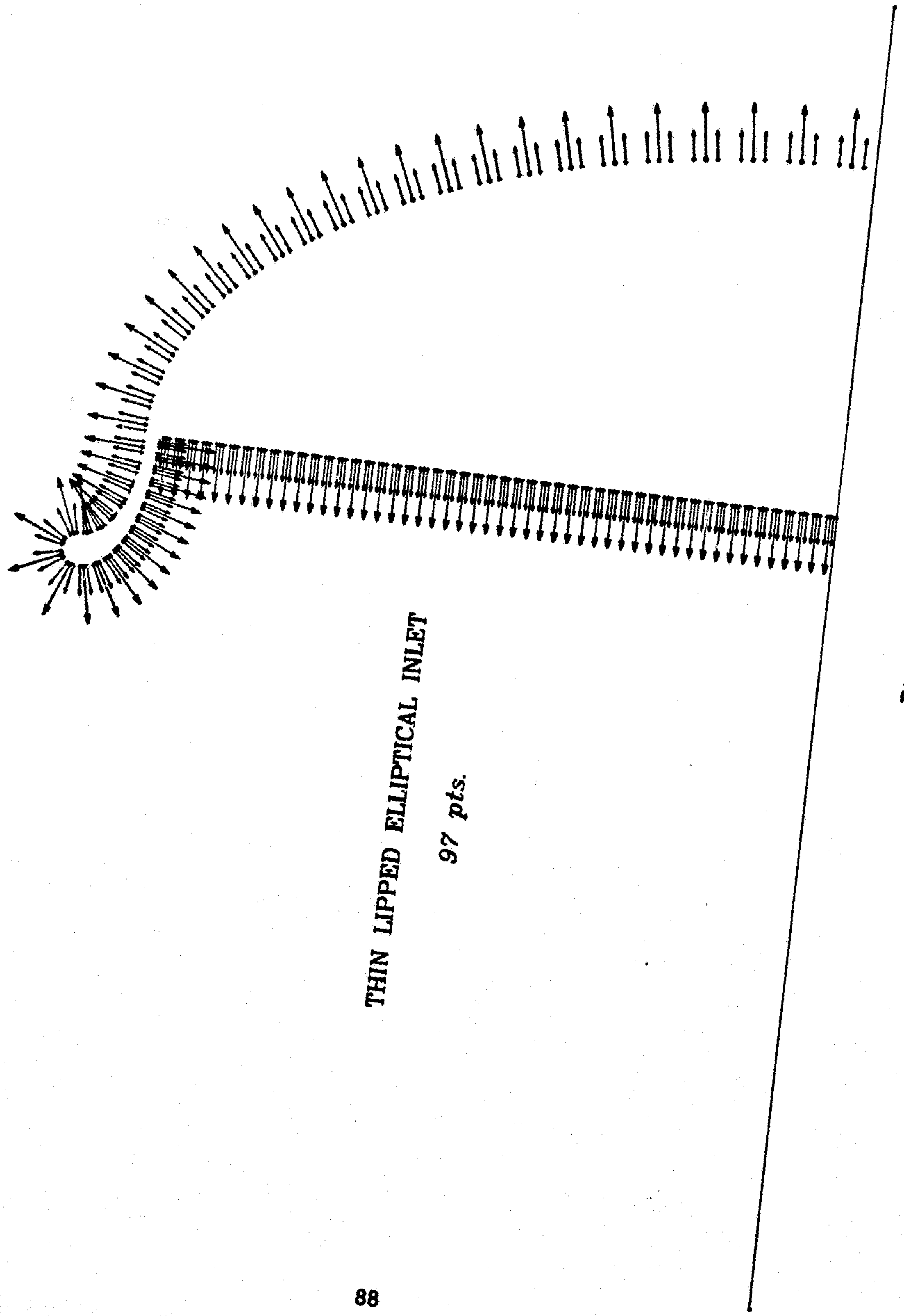
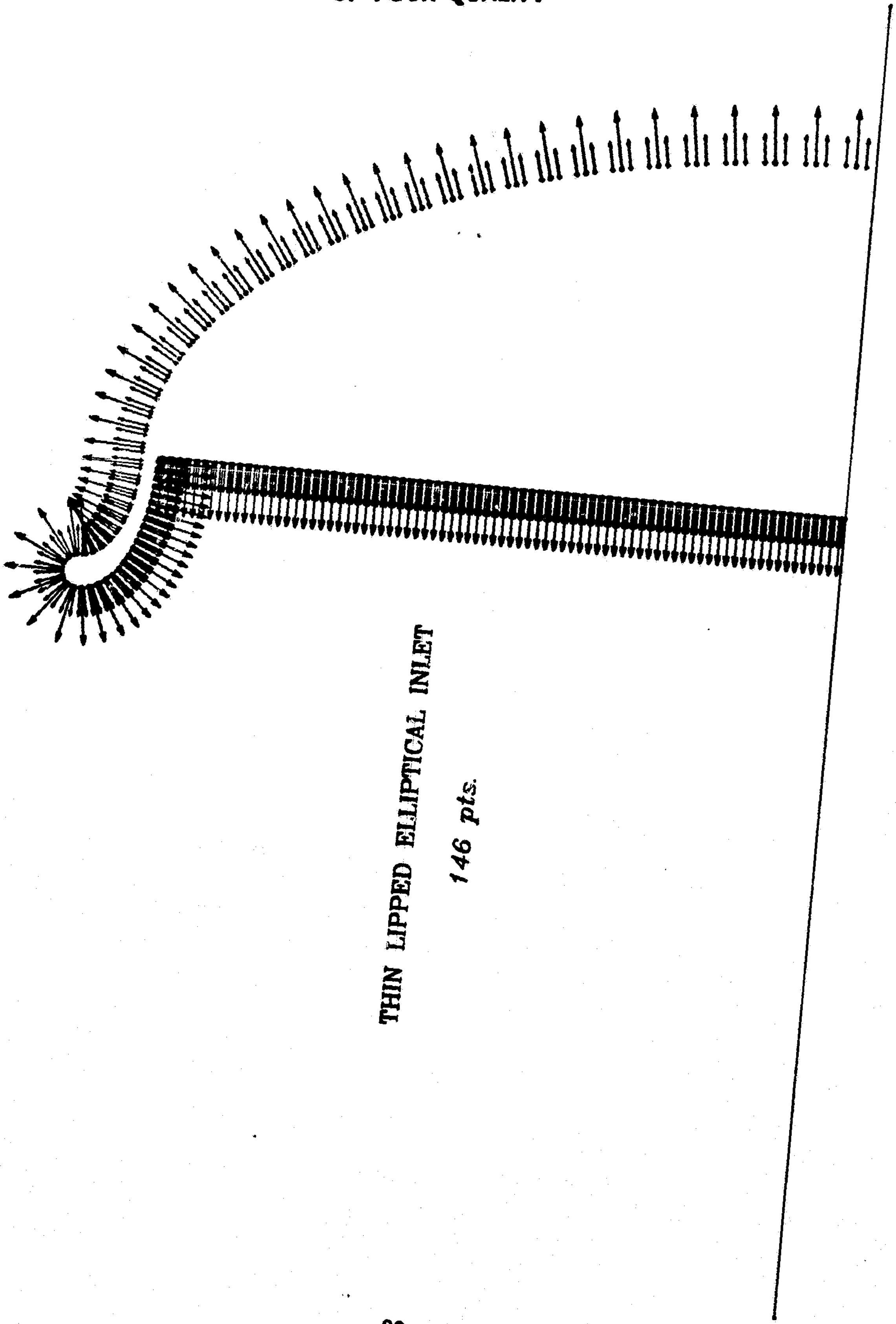


THIN LIPPED ELLIPTICAL INLET

97 pts.

Fig. 17



THIN LIPPED ELLIPTICAL INLET

146 pts.

Fig. 18

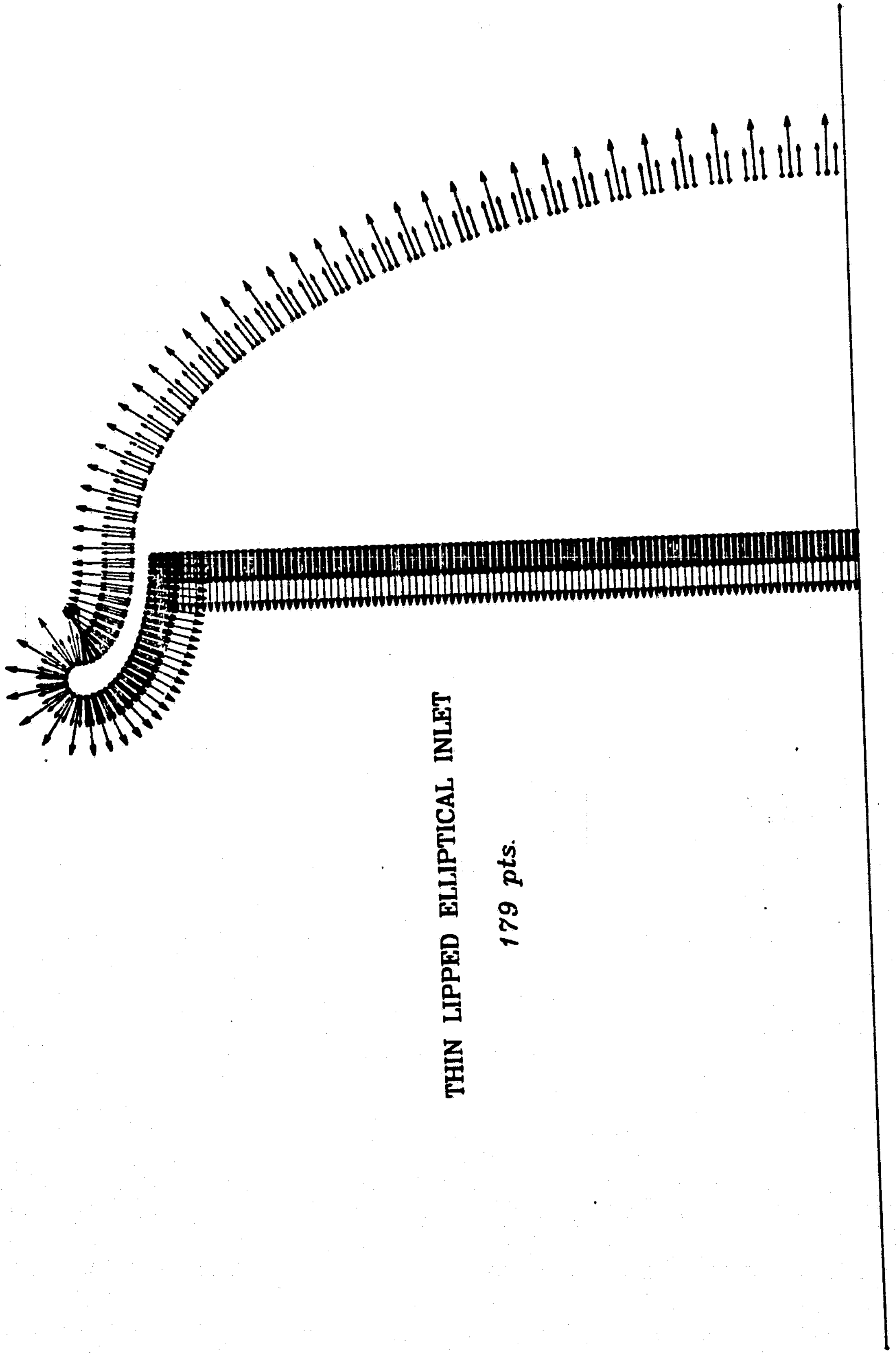


Fig. 19

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	104
2	80	48	104
4	86	50	104
6	89	52	104
8	92	54	104
10	94	56	104
12	95	58	104
14	96	60	104
16	97	62	104
18	98	64	104
20	99	66	104
22	100	68	104
24	100	70	104
26	101	72	104
28	101	74	104
30	102	76	104
32	102	78	104
34	103	80	104
36	103	82	104
38	103	84	104
40	103	86	104
42	103	88	104
44	104	90	104

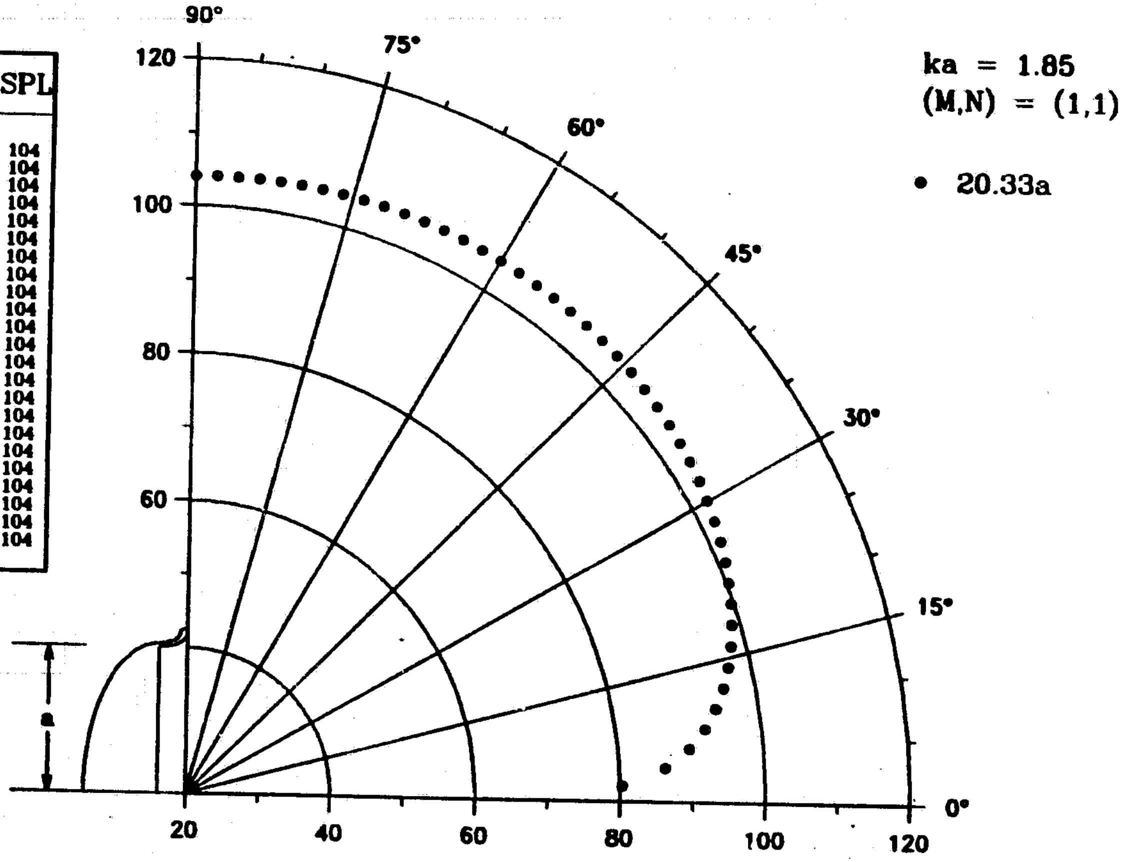


Fig. 20a

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	104
2	80	48	104
4	86	50	104
6	90	52	104
8	92	54	104
10	94	56	104
12	95	58	104
14	97	60	104
16	98	62	104
18	99	64	104
20	99	66	104
22	100	68	104
24	101	70	104
26	101	72	104
28	102	74	104
30	102	76	104
32	102	78	104
34	103	80	104
36	103	82	104
38	103	84	104
40	103	86	104
42	104	88	104
44	104	90	104

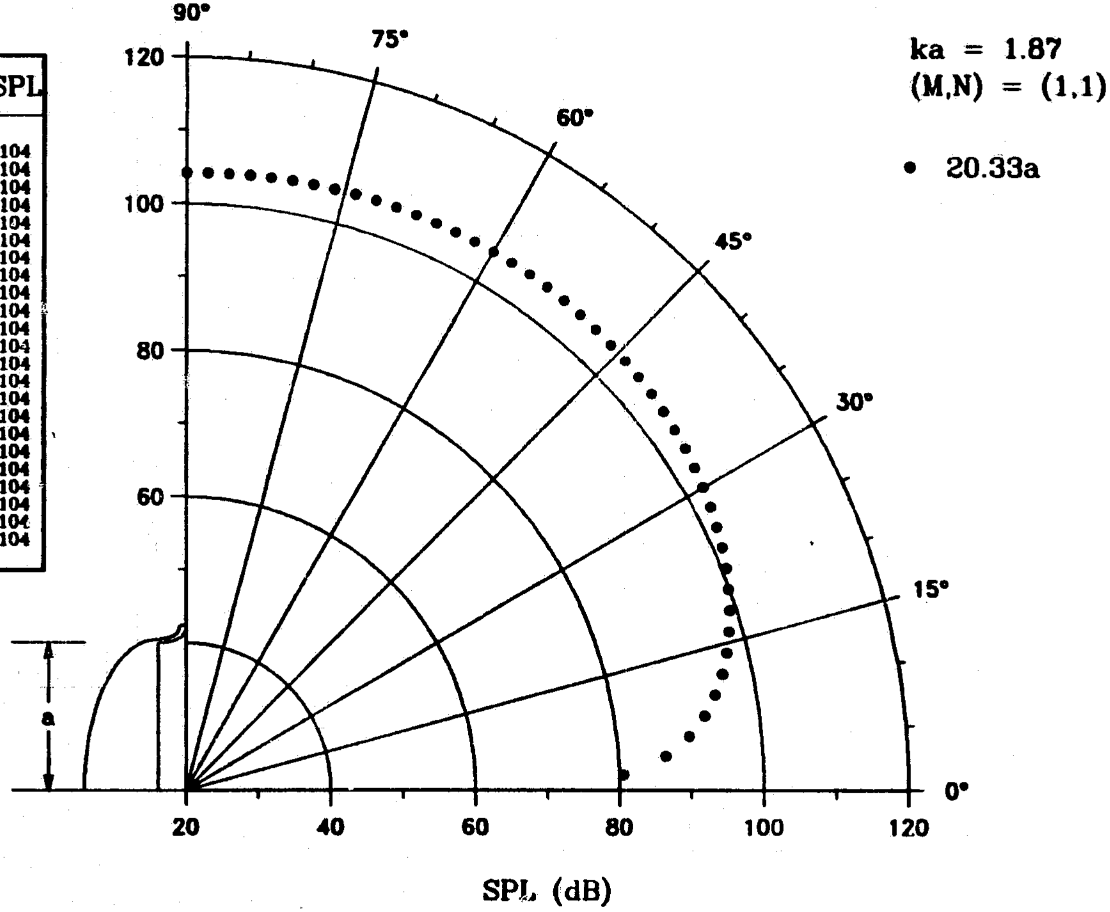


Fig. 20b

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	105
2	81	48	105
4	87	50	105
6	91	52	105
8	93	54	105
10	95	56	105
12	97	58	105
14	98	60	105
16	99	62	105
18	100	64	105
20	101	66	105
22	101	68	105
24	102	70	105
26	102	72	105
28	103	74	105
30	103	76	105
32	104	78	104
34	104	80	104
36	104	82	104
38	104	84	104
40	104	86	104
42	105	88	104
44	105	90	104

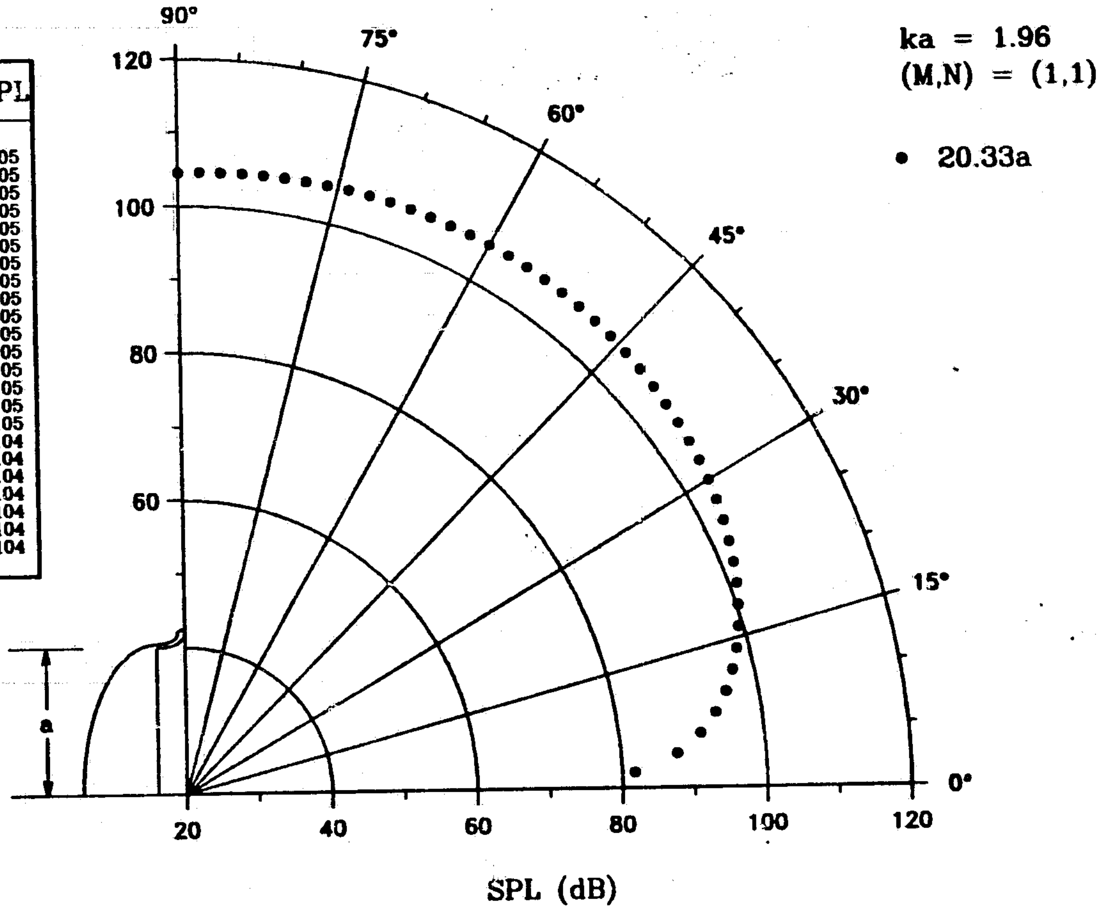


Fig. 20c

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	107
2	83	48	107
4	89	50	107
6	93	52	107
8	95	54	107
10	97	56	107
12	99	58	107
14	100	60	107
16	101	62	106
18	102	64	106
20	103	66	106
22	103	68	106
24	104	70	106
26	104	72	106
28	105	74	106
30	105	76	106
32	105	78	105
34	106	80	105
36	106	82	105
38	106	84	105
40	106	86	105
42	106	88	105
44	107	90	105

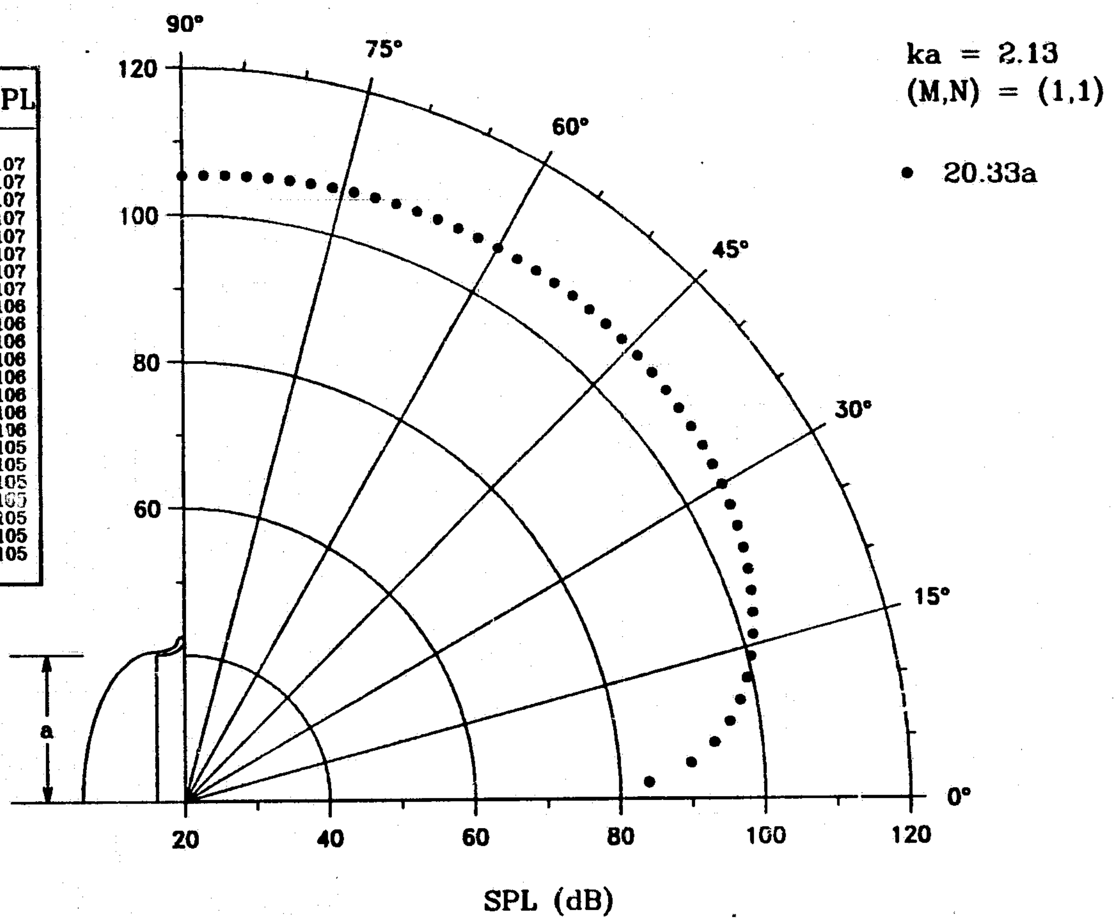


Fig. 20d

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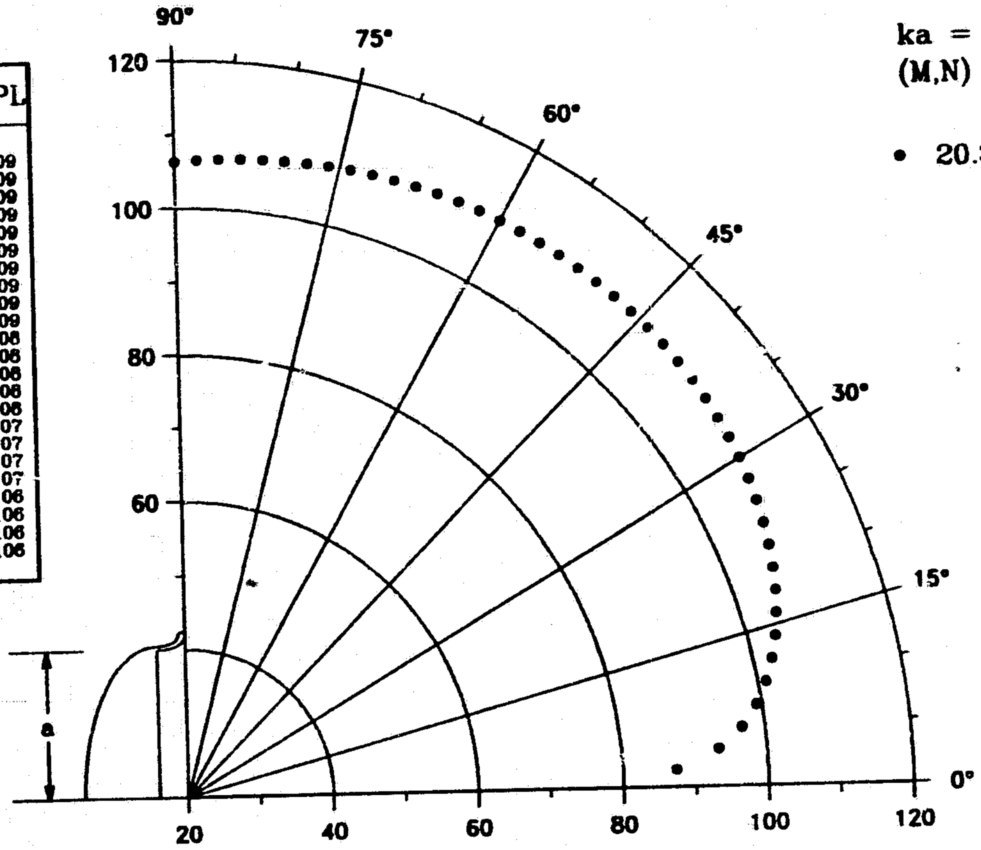
THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	109
2	87	48	109
4	93	50	109
6	96	52	109
8	99	54	109
10	101	56	109
12	102	58	109
14	103	60	109
16	104	62	109
18	105	64	109
20	106	66	108
22	107	68	108
24	107	70	108
26	108	72	108
28	108	74	108
30	108	76	107
32	109	78	107
34	109	80	107
36	109	82	107
38	109	84	106
40	109	86	106
42	109	88	106
44	109	90	106



ka = 2.40
(M,N) = (1,1)

• 20.33a

SPL (dB)

Fig. 20e

ORIGINAL PAGE IS
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THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	113
2	92	48	113
4	96	50	113
6	101	52	113
8	104	54	113
10	106	56	113
12	107	58	113
14	108	60	112
16	109	62	112
18	110	64	112
20	111	66	112
22	111	68	111
24	112	70	111
26	112	72	111
28	113	74	110
30	113	76	110
32	113	78	110
34	113	80	109
36	113	82	109
38	113	84	109
40	113	86	108
42	113	88	108
44	113	90	108

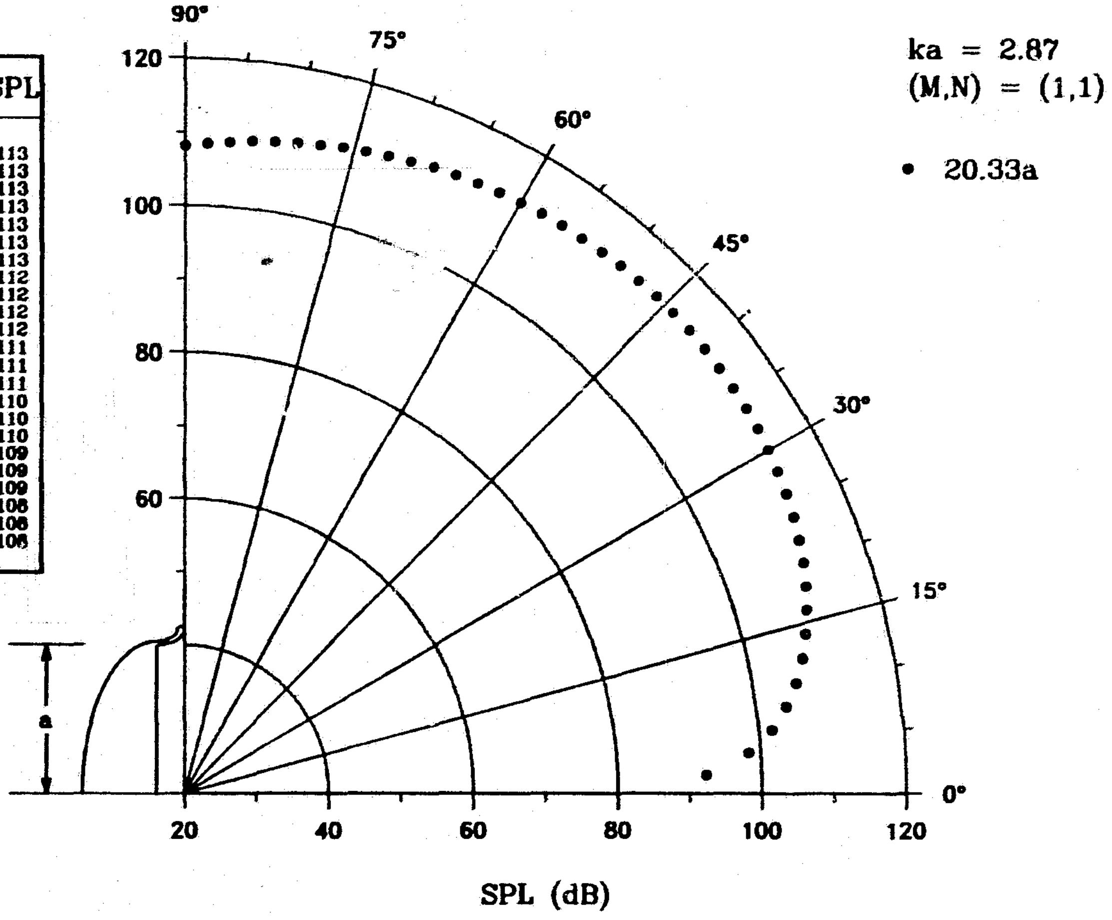


Fig. 20f

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	119
2	100	48	118
4	106	50	118
6	109	52	118
8	112	54	117
10	113	56	117
12	115	58	117
14	116	60	116
16	117	62	116
18	118	64	115
20	118	66	115
22	119	68	114
24	119	70	114
26	119	72	113
28	120	74	113
30	120	76	113
32	120	78	112
34	120	80	112
36	120	82	111
38	120	84	111
40	119	86	110
42	119	88	110
44	119	90	110

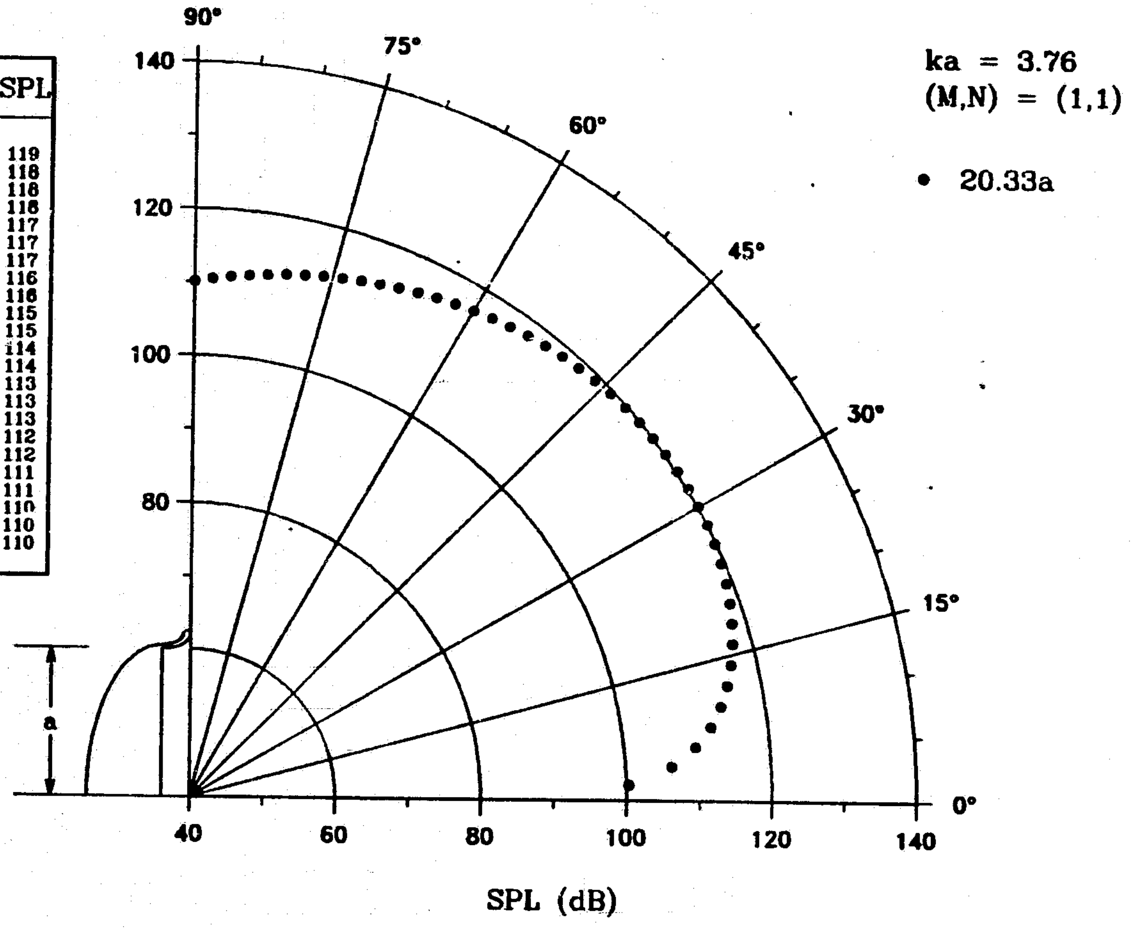


Fig. 20g

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	122
2	106	48	121
4	112	50	120
6	115	52	120
8	118	54	119
10	119	56	118
12	121	58	118
14	122	60	117
16	123	62	116
18	123	64	115
20	124	66	114
22	124	68	114
24	124	70	113
26	124	72	112
28	124	74	111
30	124	76	111
32	124	78	110
34	124	80	109
36	124	82	109
38	123	84	108
40	123	86	108
42	123	88	107
44	122	90	107

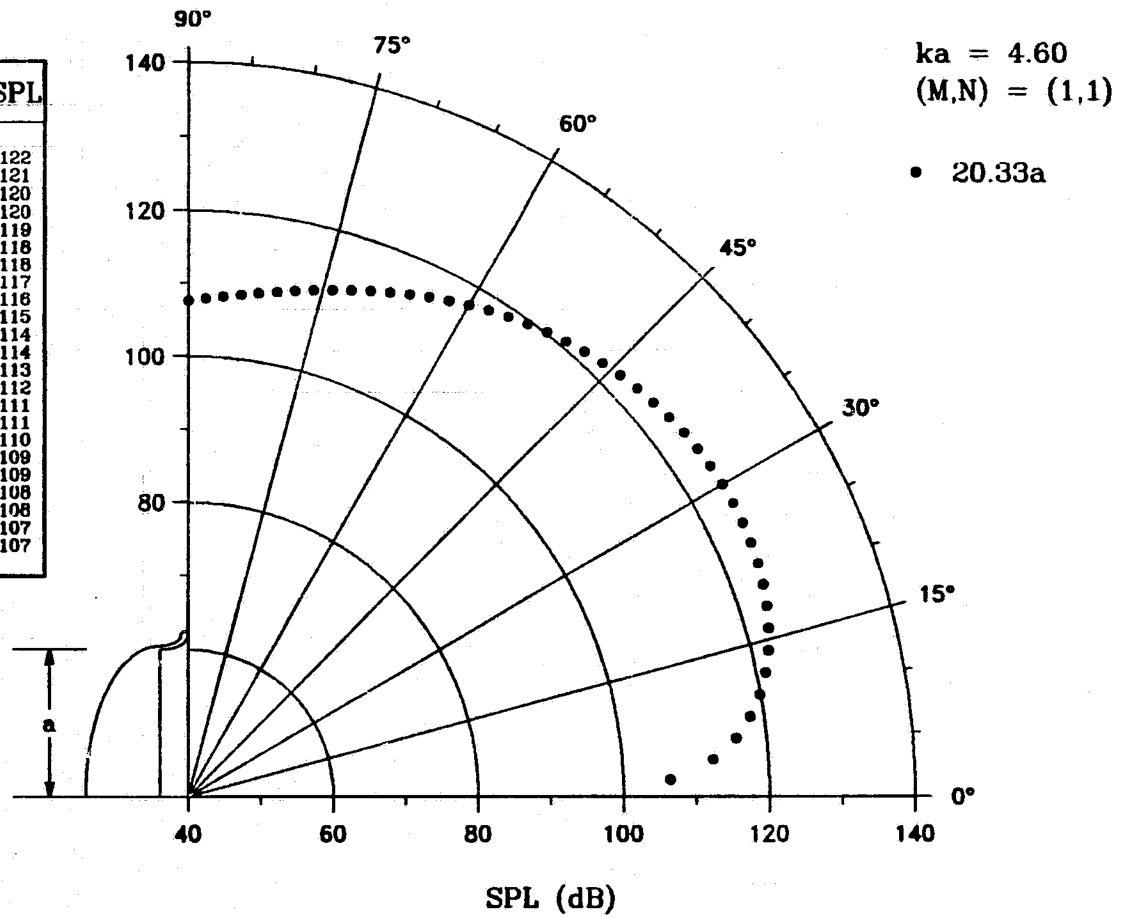


Fig. 20h

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	122
2	110	48	121
4	116	50	120
6	119	52	119
8	121	54	118
10	123	56	117
12	124	58	116
14	125	60	115
16	126	62	113
18	127	64	112
20	127	66	111
22	127	68	110
24	127	70	109
26	127	72	108
28	127	74	107
30	127	76	106
32	127	78	106
34	126	80	106
36	126	82	105
38	125	84	105
40	124	86	105
42	124	88	105
44	123	90	105

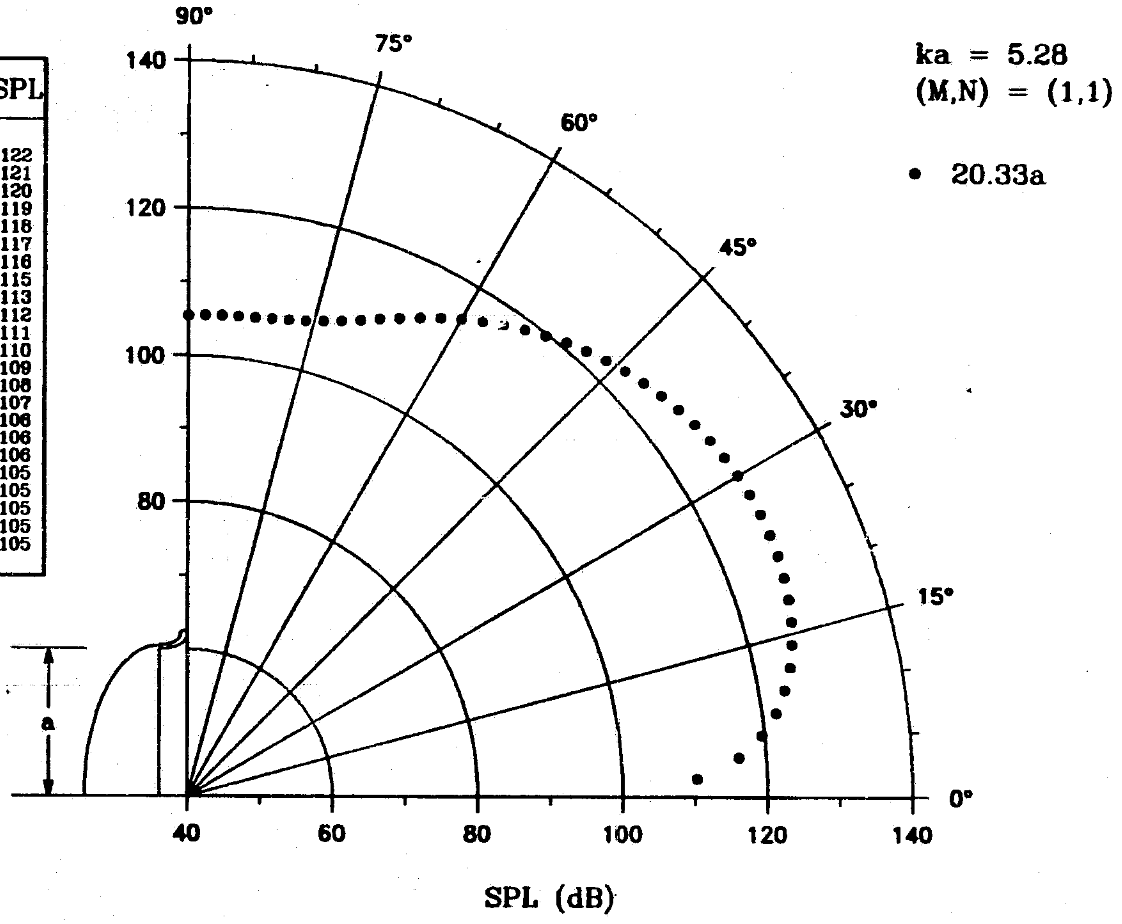


Fig. 20i

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	104
2	56	48	105
4	68	50	105
6	75	52	105
8	80	54	105
10	84	56	105
12	87	58	105
14	89	60	105
16	91	62	105
18	93	64	105
20	95	66	105
22	96	68	105
24	97	70	105
26	99	72	105
28	99	74	105
30	100	76	105
32	101	78	105
34	102	80	105
36	102	82	105
38	103	84	105
40	103	86	105
42	104	88	105
44	104	90	104

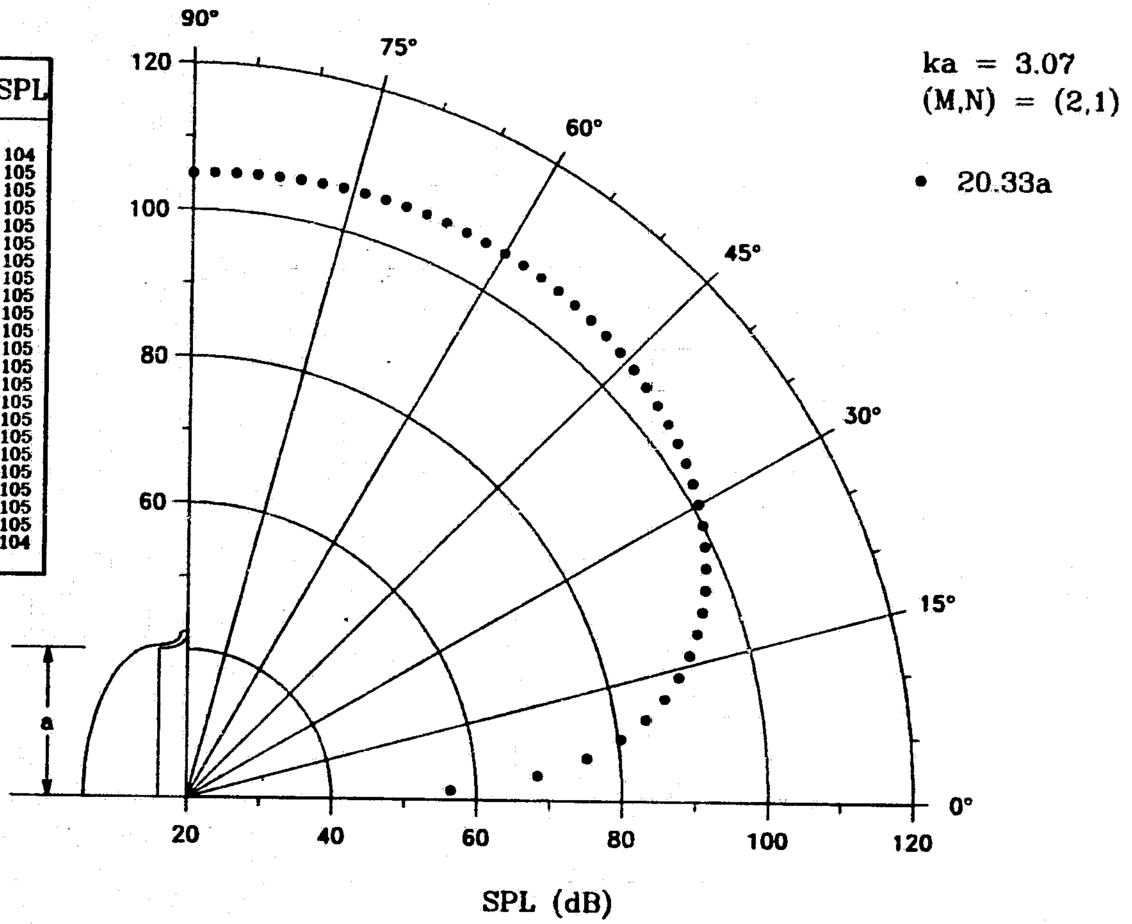
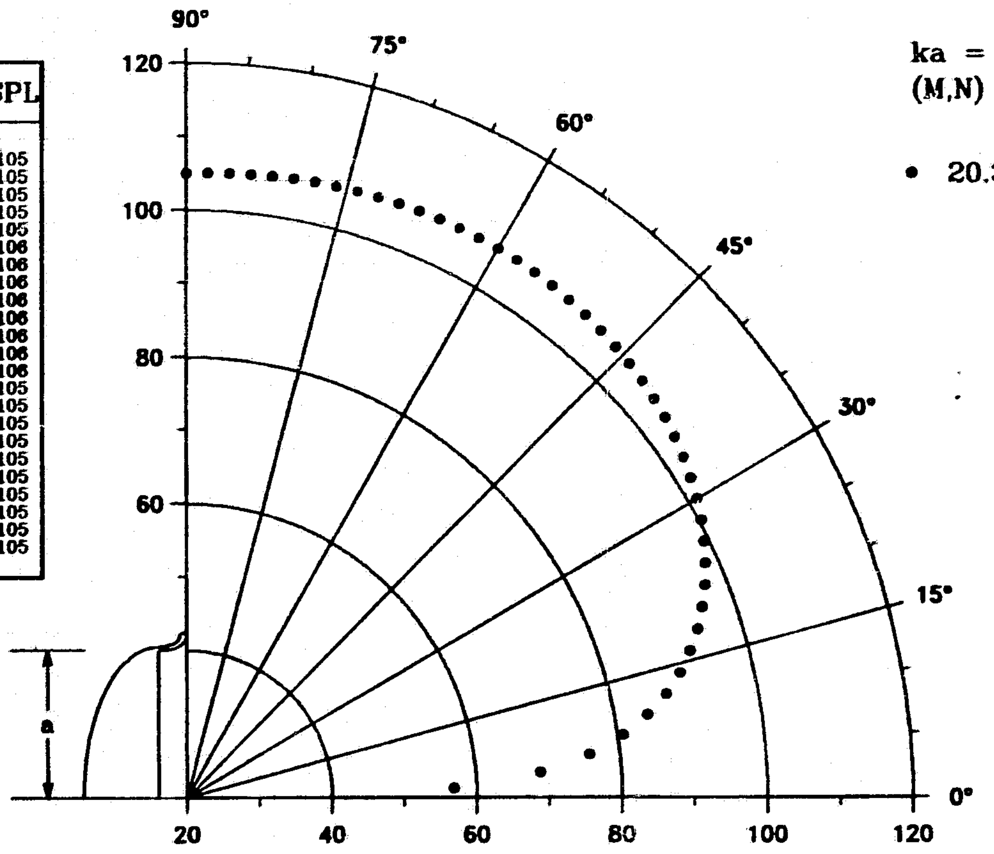


Fig. 21a

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	105
2	56	48	105
4	68	50	105
6	75	52	105
8	80	54	105
10	84	56	106
12	87	58	106
14	90	60	106
16	92	62	106
18	94	64	106
20	95	66	106
22	97	68	106
24	98	70	106
26	99	72	105
28	100	74	105
30	101	76	105
32	101	78	105
34	102	80	105
36	103	82	105
38	103	84	105
40	104	86	105
42	104	88	105
44	104	90	105



$ka = 3.10$
$(M,N) = (2,1)$

• 20.33a

Fig. 21b

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	106
2	58	48	106
4	70	50	107
6	77	52	107
8	82	54	107
10	86	56	107
12	89	58	107
14	91	60	107
16	93	62	107
18	95	64	107
20	97	66	107
22	98	68	107
24	100	70	107
26	101	72	106
28	102	74	106
30	102	76	106
32	103	78	106
34	104	80	106
36	104	82	106
38	105	84	106
40	105	86	105
42	106	88	105
44	106	90	105

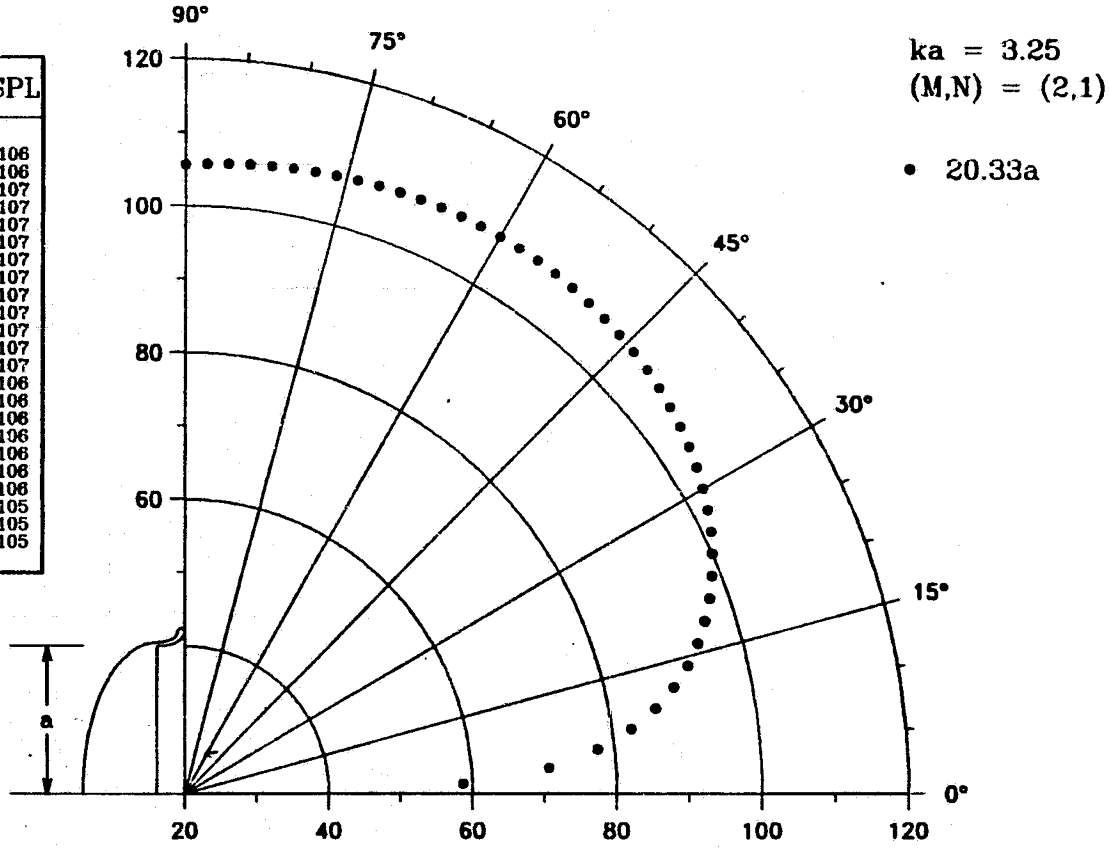


Fig. 21c

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	109
2	61	48	109
4	73	50	109
6	80	52	109
8	85	54	109
10	89	56	109
12	92	58	109
14	95	60	109
16	97	62	109
18	98	64	109
20	100	66	109
22	101	68	109
24	103	70	109
26	104	72	108
28	105	74	108
30	105	76	108
32	106	78	108
34	107	80	107
36	107	82	107
38	108	84	107
40	108	86	107
42	108	88	106
44	109	90	106

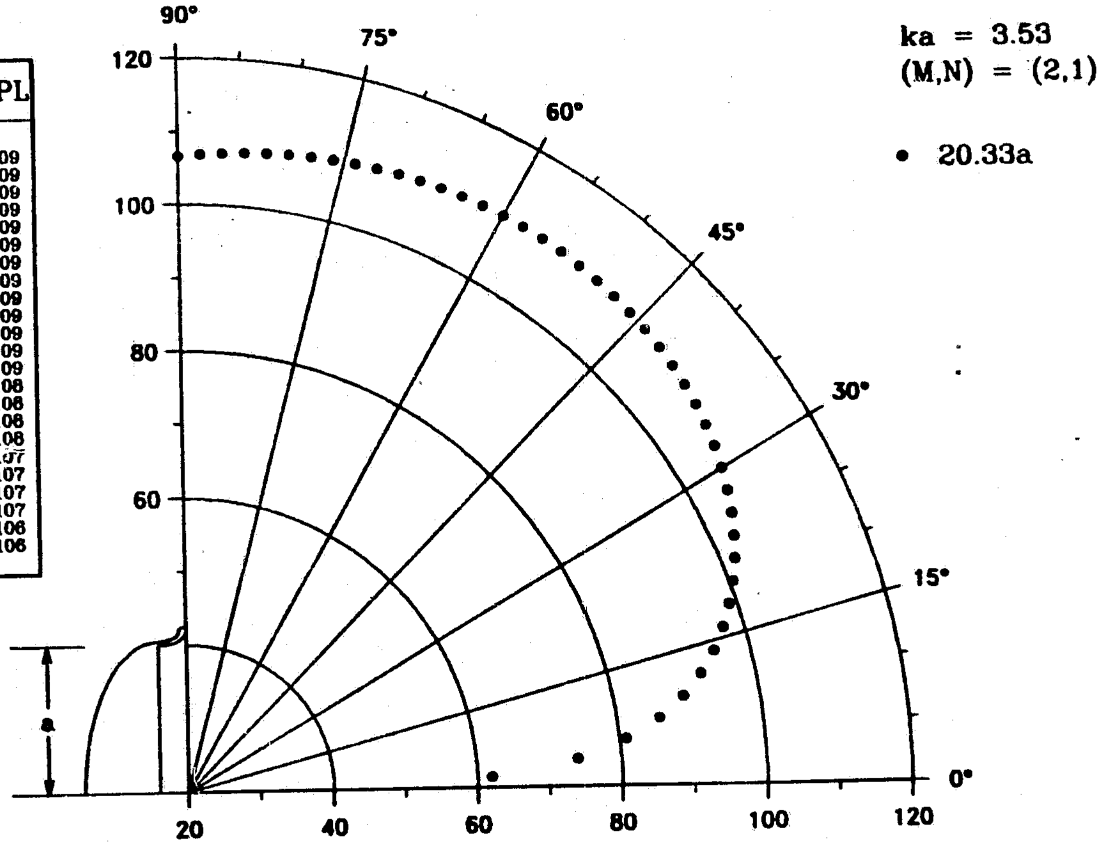
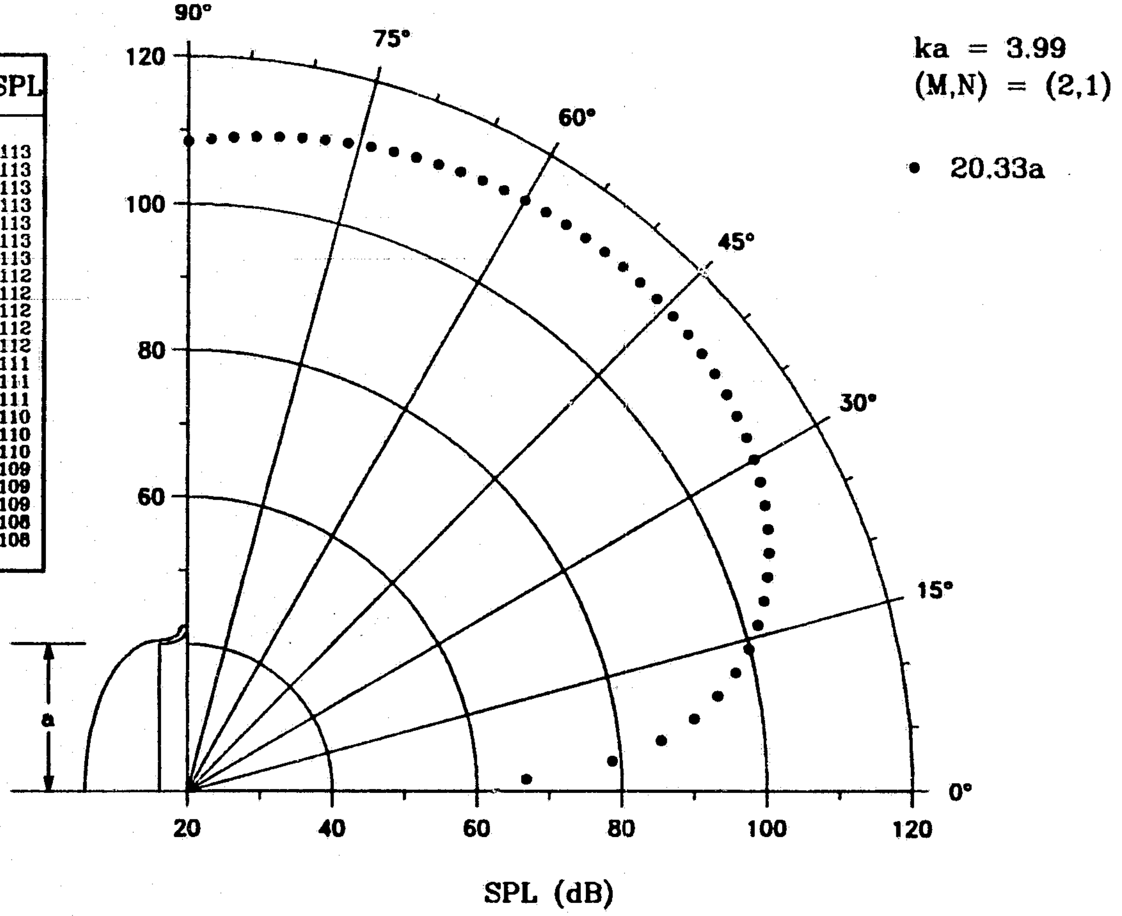


Fig. 21d

THIN LIPPED ELLIPTICAL INLET

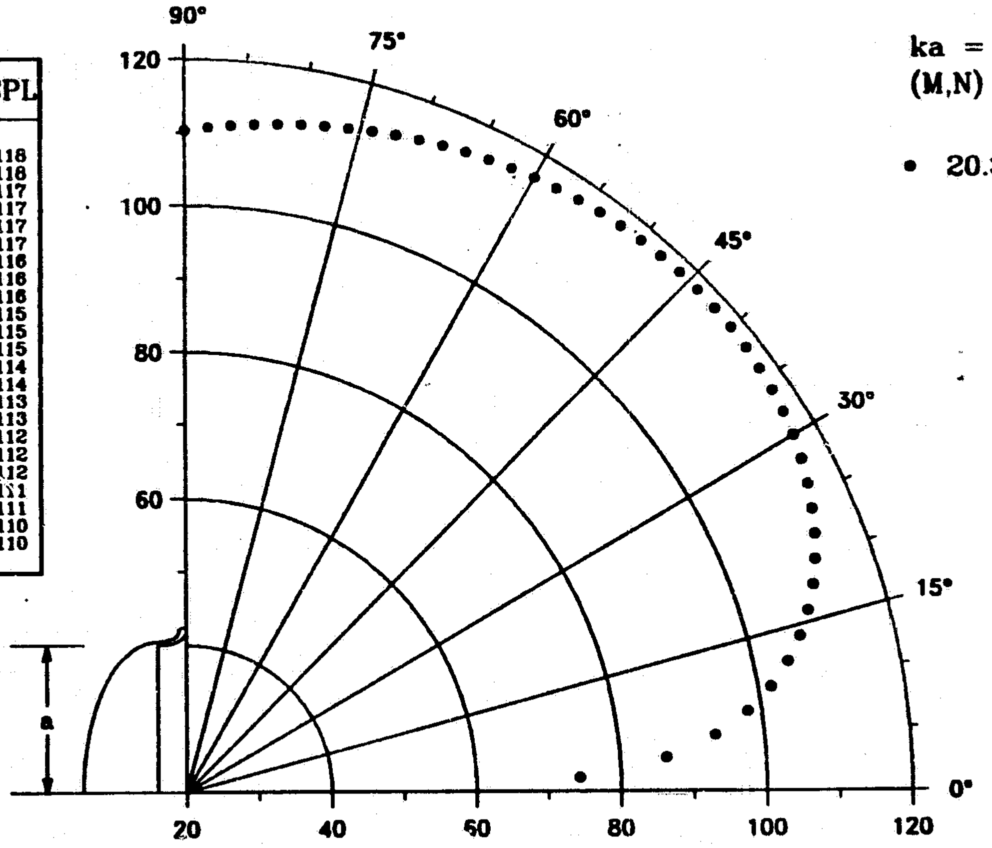
Deg	SPL	Deg	SPL
0	0	46	113
2	66	48	113
4	78	50	113
6	85	52	113
8	90	54	113
10	94	56	113
12	97	58	113
14	99	60	112
16	101	62	112
18	103	64	112
20	105	66	112
22	106	68	112
24	107	70	111
26	108	72	111
28	109	74	111
30	110	76	110
32	110	78	110
34	111	80	110
36	111	82	109
38	112	84	109
40	112	86	109
42	112	88	108
44	113	90	108



Fif. 21e

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	118
2	74	48	118
4	86	50	117
6	93	52	117
8	96	54	117
10	101	56	117
12	104	58	116
14	107	60	116
16	109	62	116
18	110	64	115
20	112	66	115
22	113	68	115
24	114	70	114
26	115	72	114
28	116	74	113
30	116	76	113
32	117	78	112
34	117	80	112
36	117	82	112
38	118	84	111
40	118	86	111
42	118	88	110
44	118	90	110



ka = 4.75
(M,N) = (2,1)

• 20.33a

Fig. 21f

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	120
2	79	48	120
4	91	50	120
6	97	52	119
8	102	54	119
10	106	56	119
12	109	58	118
14	111	60	118
16	113	62	117
18	115	64	116
20	116	66	116
22	117	68	115
24	118	70	115
26	119	72	114
28	120	74	113
30	120	76	113
32	120	78	112
34	121	80	112
36	121	82	111
38	121	84	111
40	121	86	110
42	121	88	110
44	121	90	109

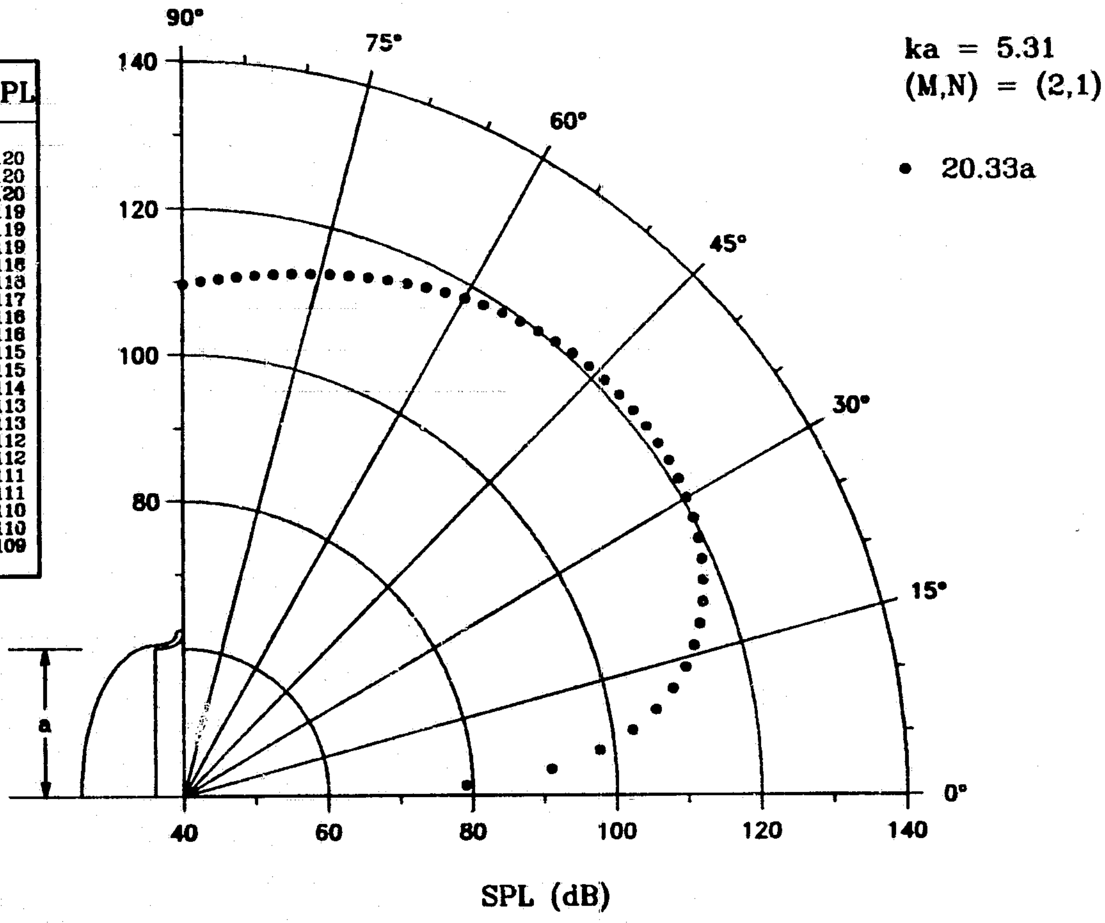
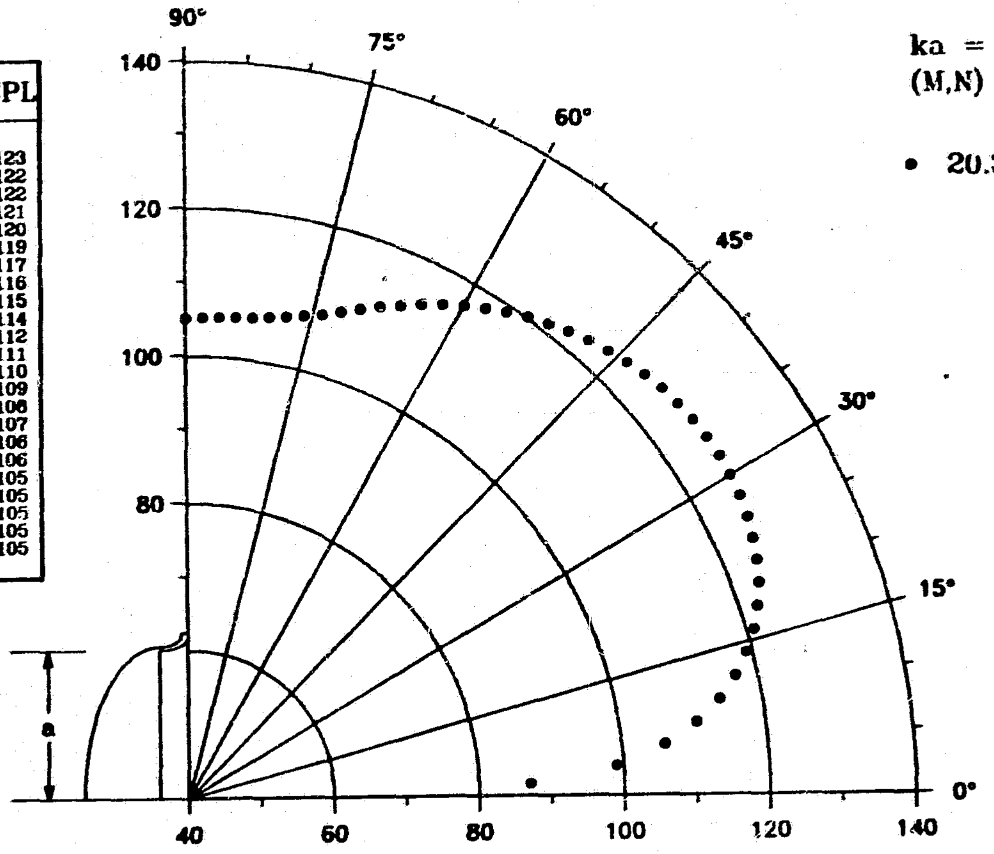


Fig. 21g

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	123
2	87	48	122
4	99	50	122
6	105	52	121
8	110	54	120
10	114	56	119
12	116	58	117
14	119	60	116
16	120	62	115
18	122	64	114
20	123	66	112
22	124	68	111
24	125	70	110
26	125	72	109
28	126	74	108
30	126	76	107
32	126	78	106
34	126	80	106
36	126	82	105
38	125	84	105
40	125	86	105
42	125	88	105
44	124	90	105



ka = 6.57
(M,N) = (2,1)

• 20.33a

Fig. 21h

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	104
2	7	48	105
4	31	50	105
6	45	52	106
8	55	54	106
10	62	56	106
12	68	58	106
14	73	60	107
16	78	62	107
18	81	64	107
20	85	66	107
22	87	68	107
24	90	70	107
26	92	72	106
28	94	74	106
30	96	76	106
32	97	78	106
34	99	80	106
36	100	82	105
38	101	84	105
40	102	86	105
42	103	88	105
44	104	90	104

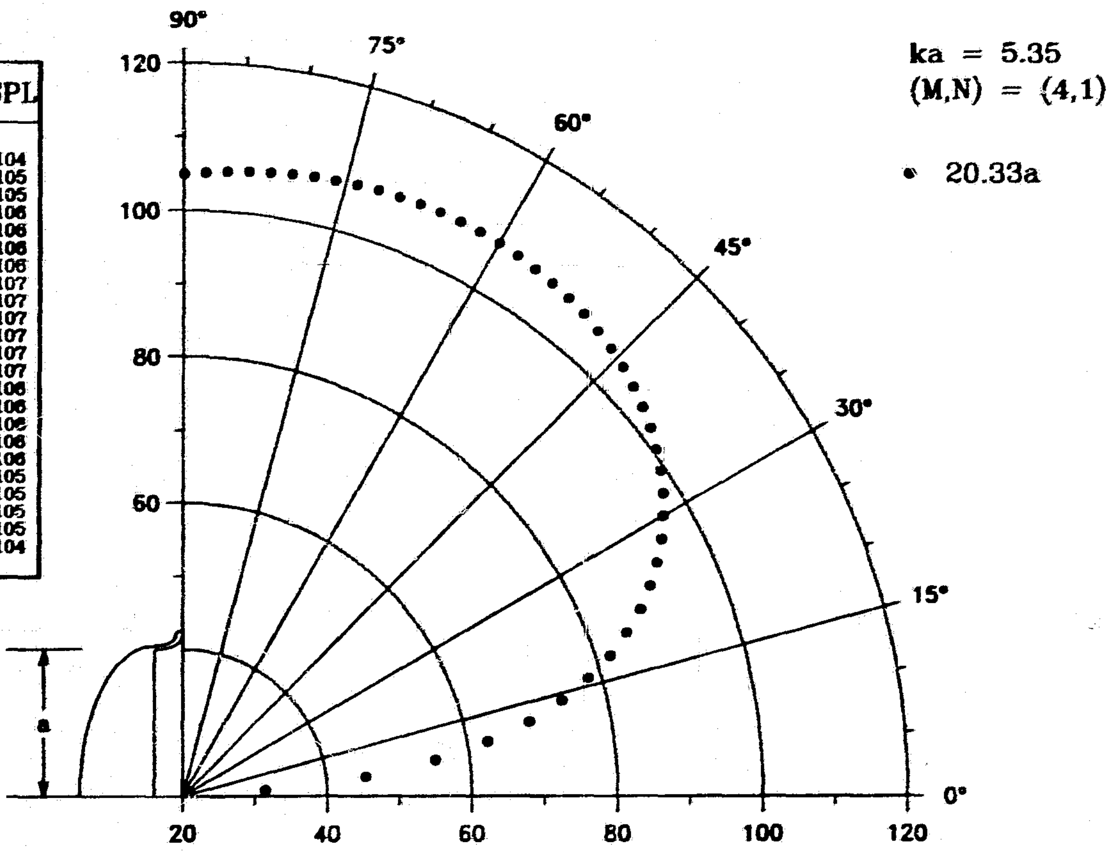


Fig. 22a

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	105
2	8	48	105
4	32	50	106
6	46	52	106
8	55	54	107
10	63	56	107
12	69	58	107
14	74	60	107
16	78	62	107
18	82	64	107
20	85	66	107
22	88	68	107
24	91	70	107
26	93	72	107
28	95	74	107
30	96	76	106
32	98	78	106
34	99	80	106
36	101	82	106
38	102	84	106
40	103	86	105
42	103	88	105
44	104	90	105

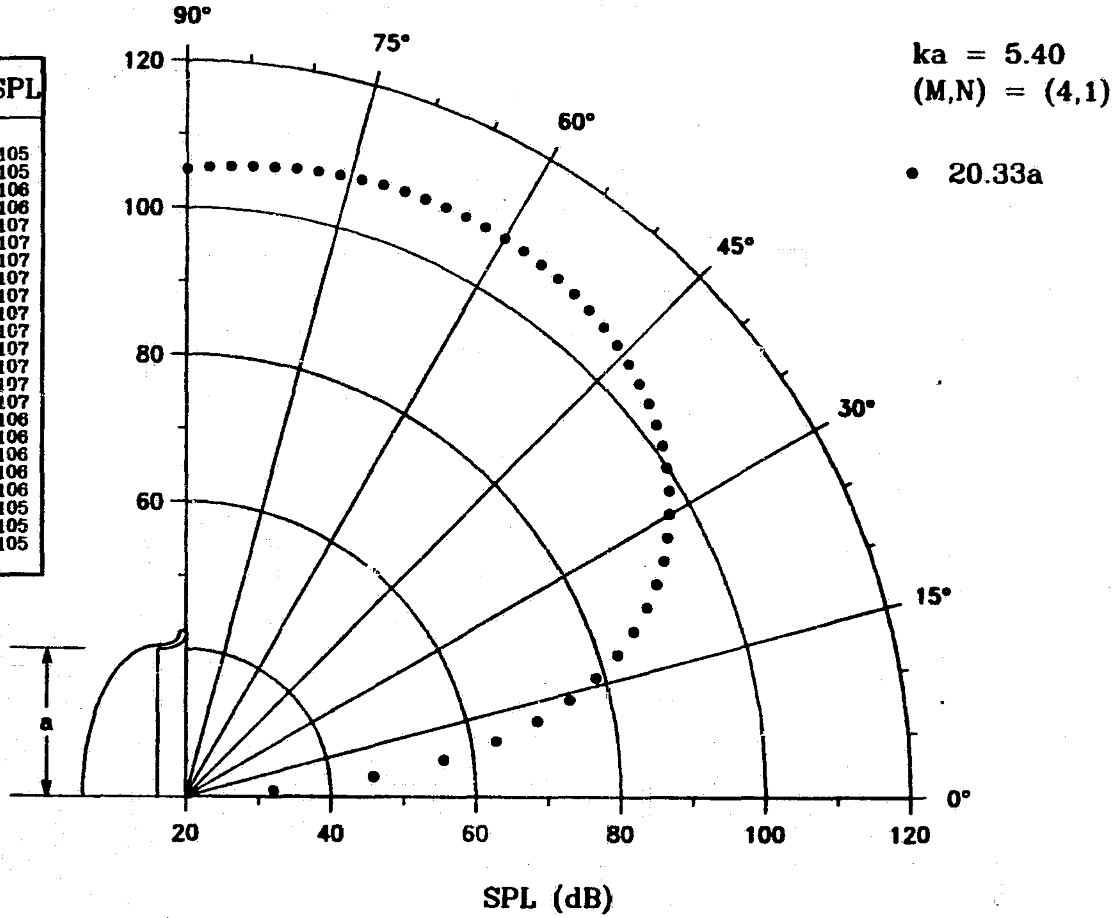
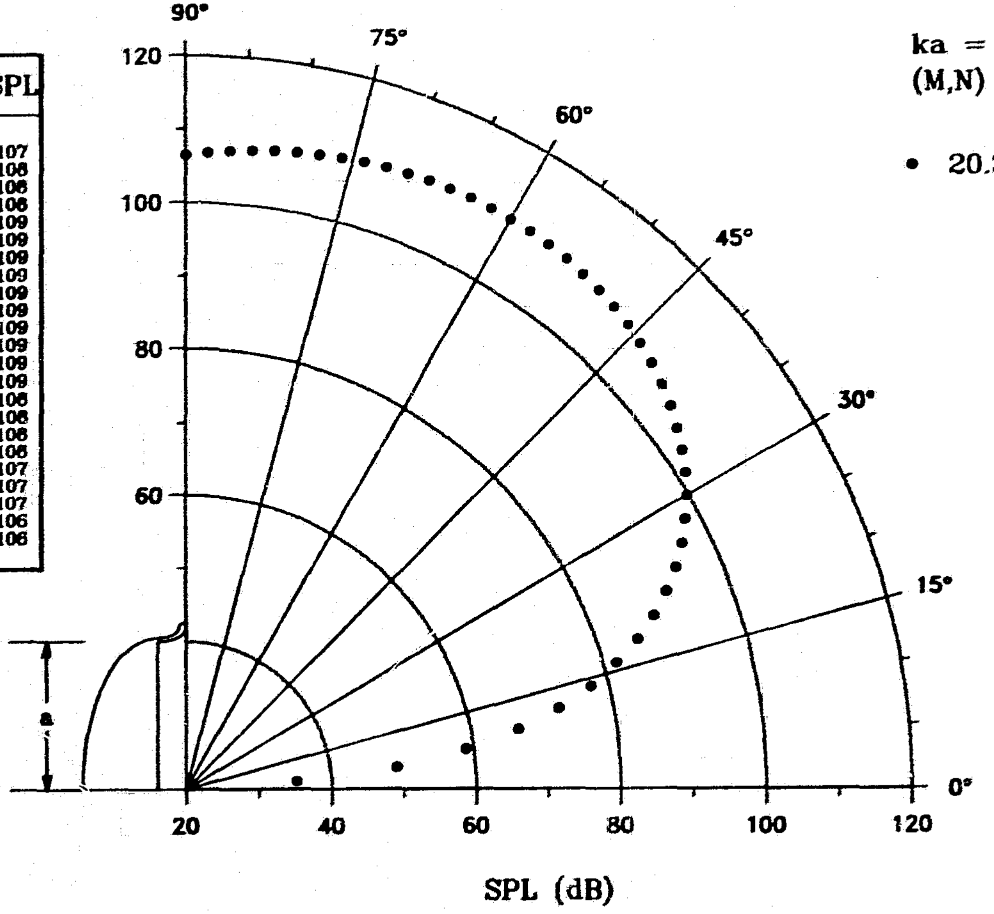


Fig. 22b

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	107
2	11	48	108
4	35	50	108
6	49	52	108
8	58	54	109
10	66	56	109
12	72	58	109
14	77	60	109
16	81	62	109
18	85	64	109
20	88	66	109
22	91	68	109
24	93	70	109
26	96	72	109
28	98	74	108
30	99	76	108
32	101	78	108
34	102	80	108
36	103	82	107
38	104	84	107
40	105	86	107
42	106	88	106
44	107	90	108



ka = 5.66
(M,N) = (4,1)

• 20.33a

Fig. 22c

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	111
2	16	48	112
4	40	50	112
6	54	52	112
8	64	54	112
10	72	56	113
12	78	58	113
14	83	60	112
16	87	62	112
18	90	64	112
20	94	66	112
22	96	68	112
24	99	70	112
26	101	72	111
28	103	74	111
30	104	76	111
32	106	78	111
34	107	80	110
36	108	82	110
38	109	84	109
40	110	86	109
42	110	88	109
44	111	90	108

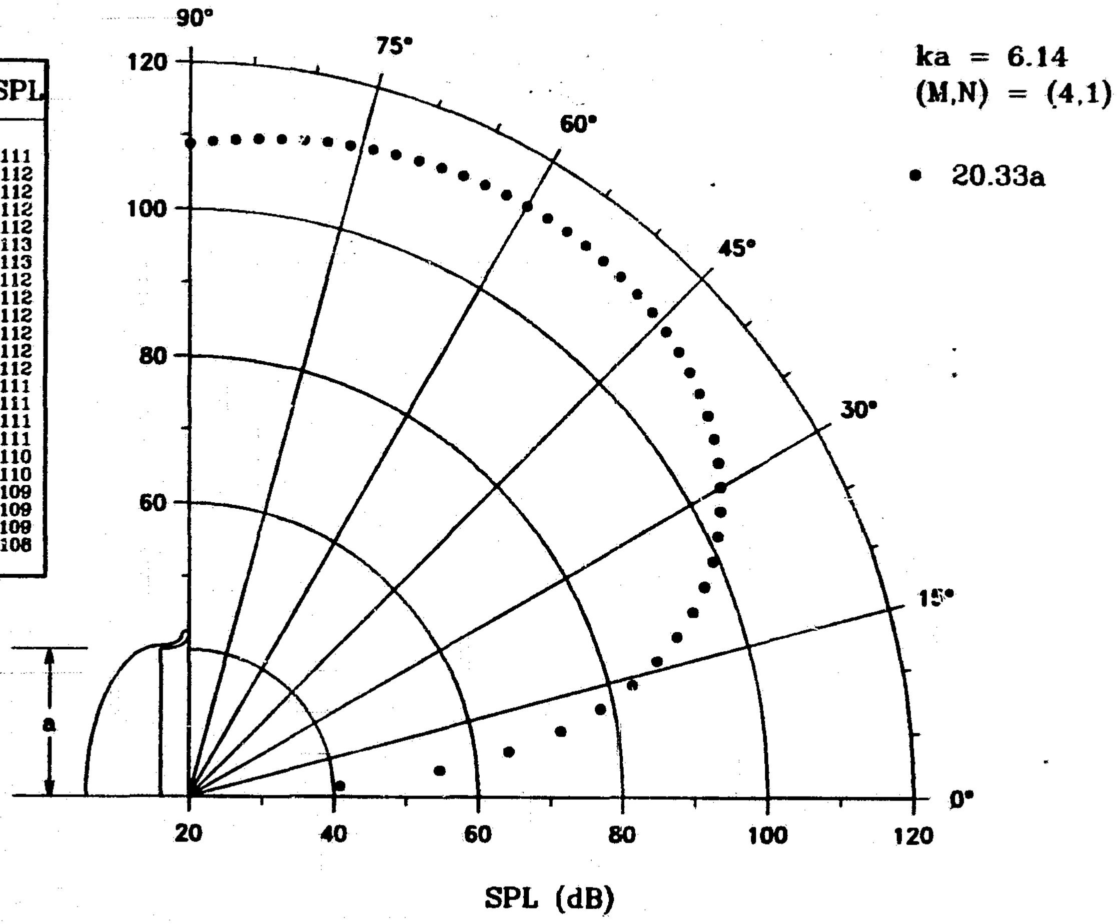


Fig. 22d

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	118
2	25	48	118
4	49	50	118
6	63	52	118
8	73	54	118
10	80	56	117
12	86	58	117
14	91	60	117
16	95	62	117
18	99	64	116
20	102	66	116
22	104	68	115
24	107	70	115
26	109	72	114
28	110	74	114
30	112	76	113
32	113	78	113
34	114	80	112
36	115	82	112
38	116	84	112
40	116	86	111
42	117	88	111
44	117	90	110

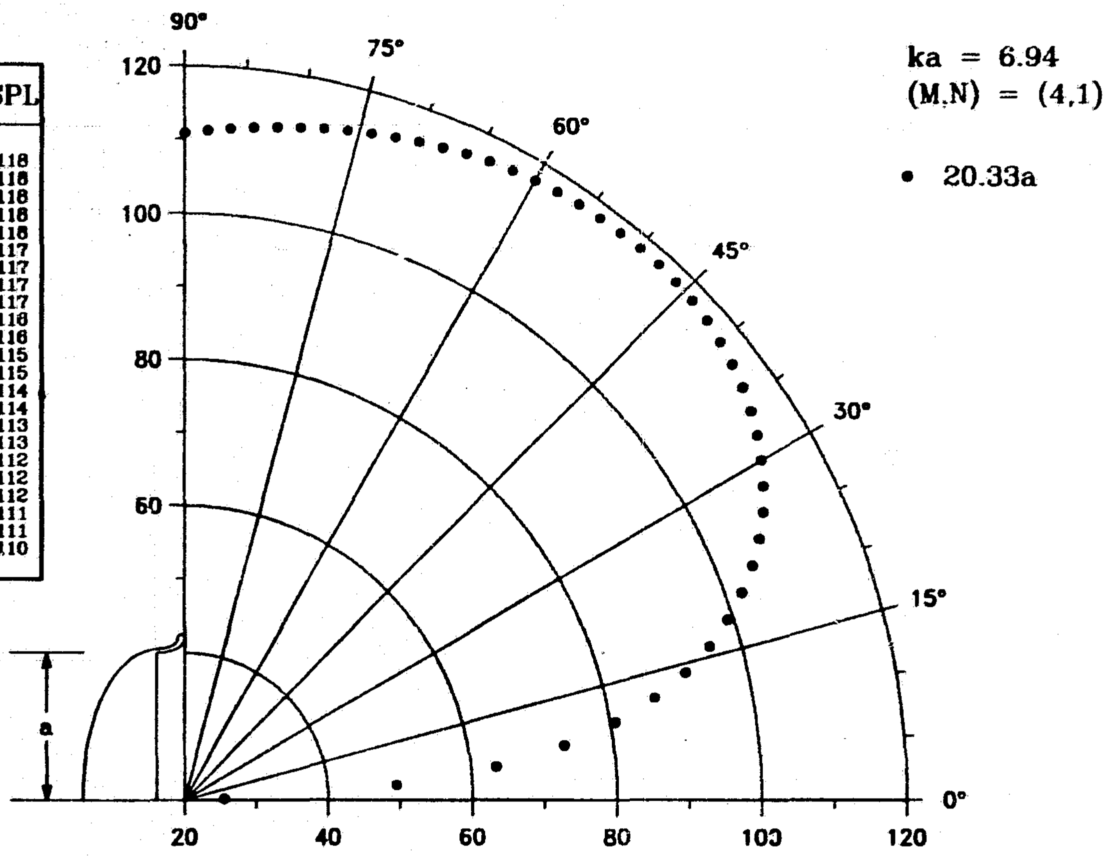


Fig. 22e

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	123
2	35	48	123
4	59	50	123
6	73	52	122
8	83	54	122
10	90	56	121
12	96	58	120
14	101	60	120
16	105	62	119
18	108	64	118
20	111	66	117
22	114	68	116
24	116	70	115
26	118	72	114
28	119	74	113
30	120	76	112
32	121	78	111
34	122	80	110
36	123	82	110
38	123	84	109
40	123	86	108
42	123	88	107
44	123	90	107

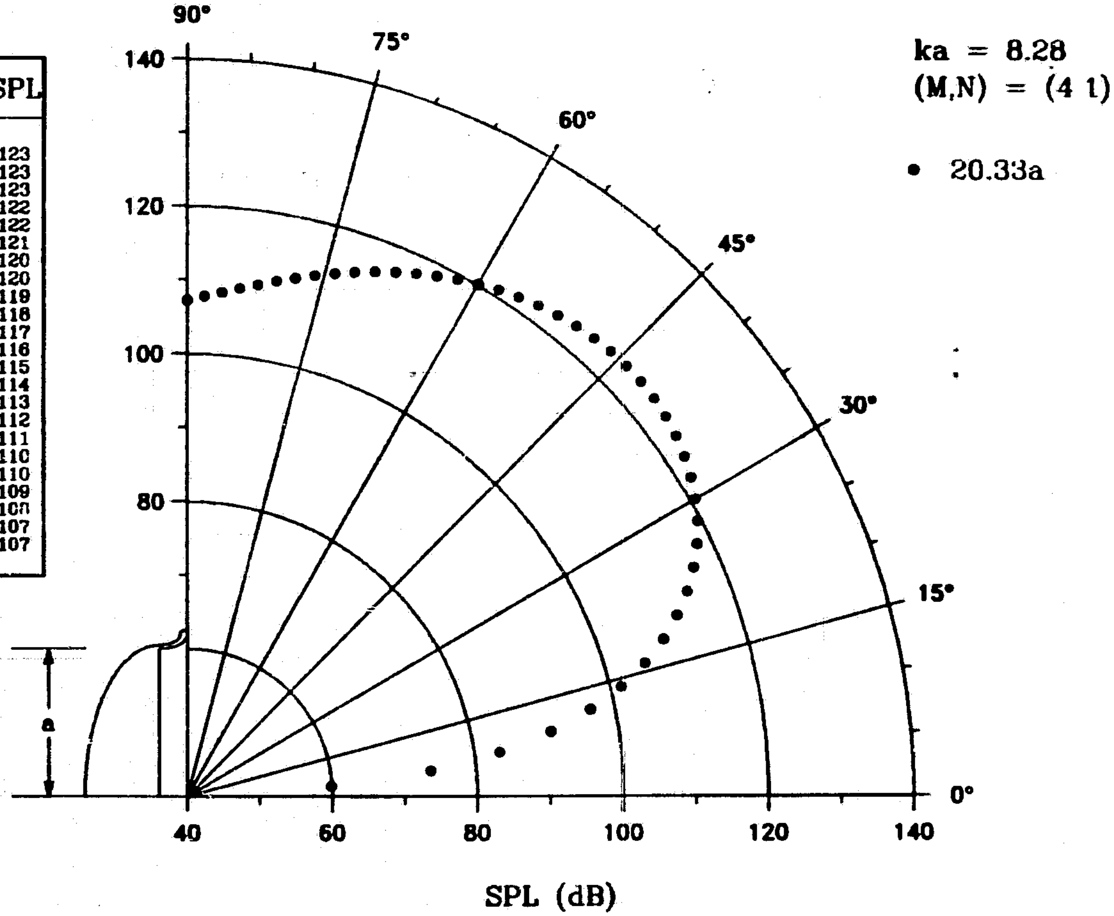


Fig. 22f

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	103
2	−91	48	104
4	−43	50	105
6	−15	52	106
8	3	54	107
10	18	56	107
12	31	58	108
14	41	60	108
16	49	62	108
18	57	64	109
20	63	66	109
22	69	68	109
24	74	70	109
26	78	72	109
28	82	74	108
30	86	76	108
32	89	78	108
34	92	80	108
36	94	82	107
38	97	84	107
40	99	86	107
42	100	88	106
44	102	90	106

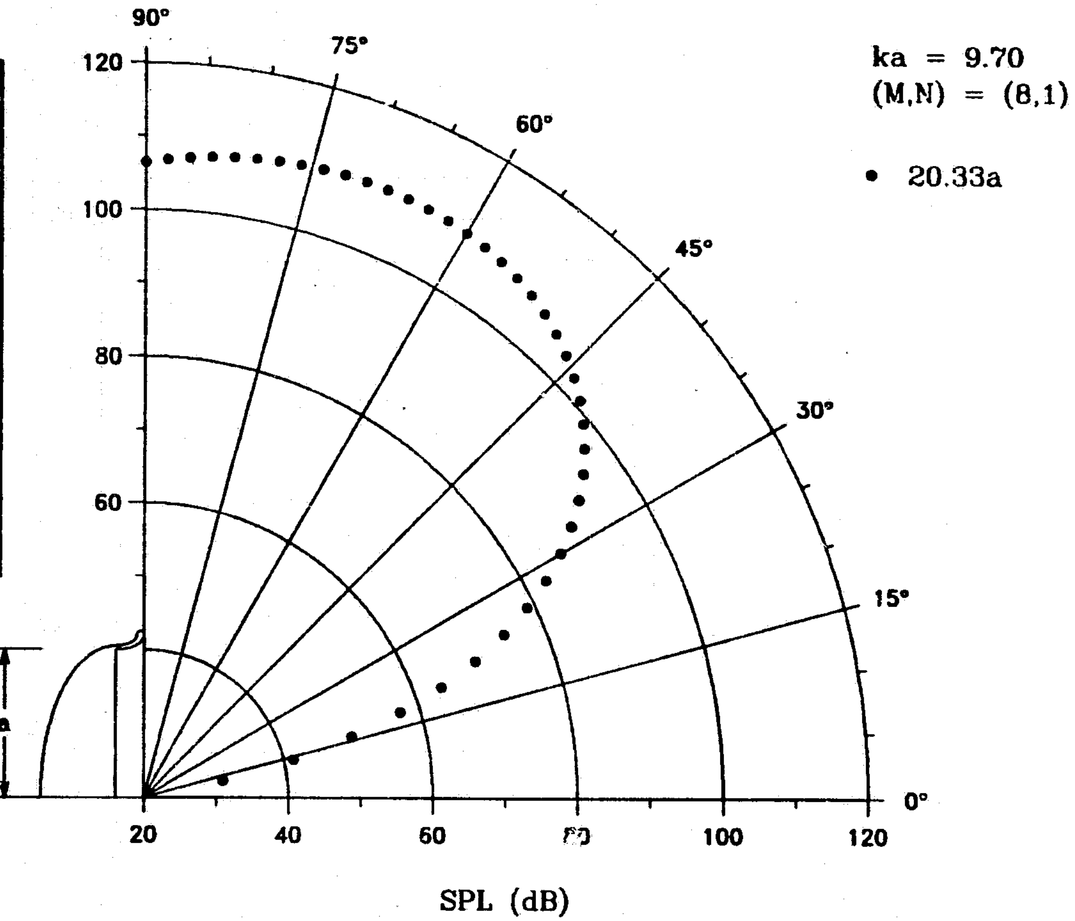


Fig. 23a

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THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	104
2	−90	48	105
4	−42	50	106
6	−14	52	107
8	5	54	108
10	20	56	108
12	32	58	109
14	43	60	109
16	51	62	109
18	58	64	109
20	64	66	109
22	70	68	109
24	75	70	109
26	80	72	109
28	84	74	109
30	87	76	109
32	90	78	109
34	93	80	108
36	96	82	108
38	98	84	108
40	100	86	107
42	101	88	107
44	103	90	106

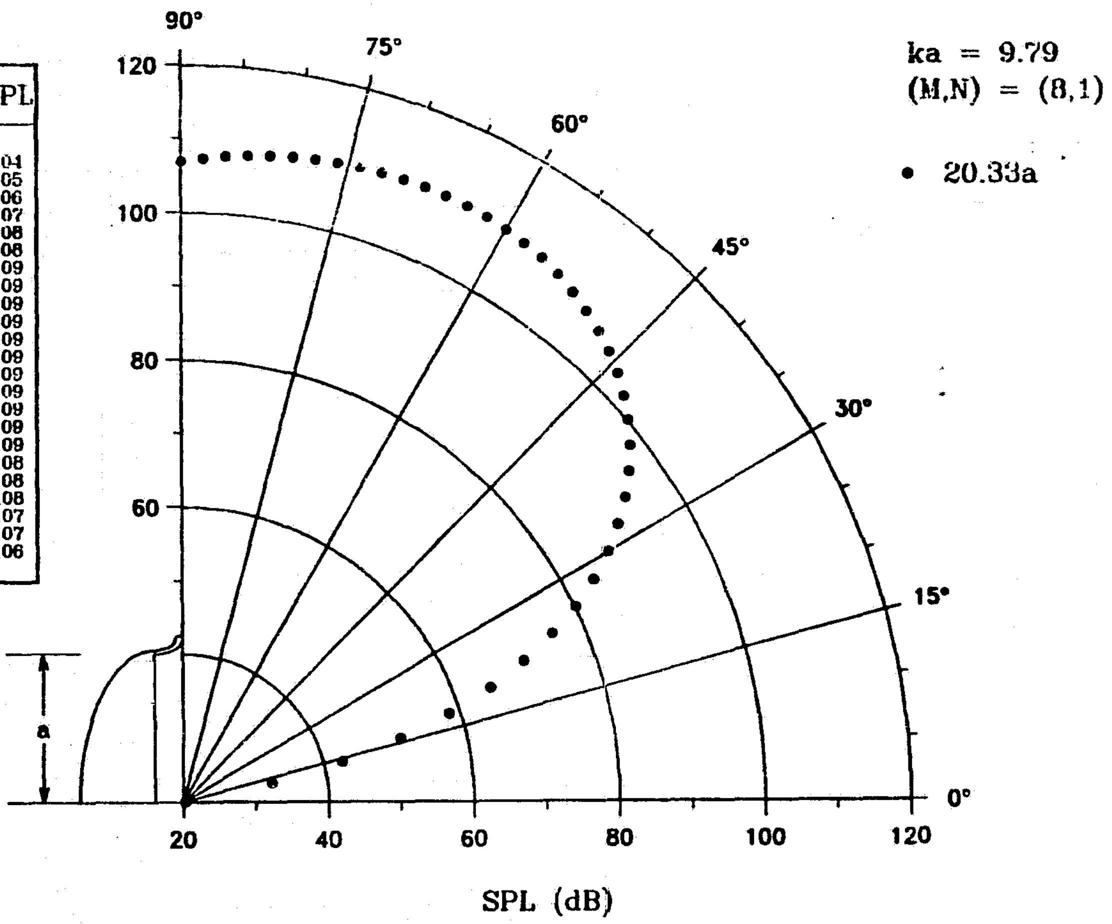


Fig. 23b

THIN LIPPED ELLIPTICAL INLET

Deg	SFL	Deg	SPL
0	0	46	109
2	−84	48	110
4	−36	50	111
6	−8	52	111
8	11	54	112
10	26	56	112
12	38	58	113
14	48	60	113
16	56	62	113
18	64	64	113
20	70	66	113
22	76	68	113
24	81	70	112
26	85	72	112
28	89	74	112
30	93	76	111
32	96	78	111
34	98	80	111
36	101	82	110
38	103	84	110
40	105	86	110
42	106	88	109
44	108	90	109

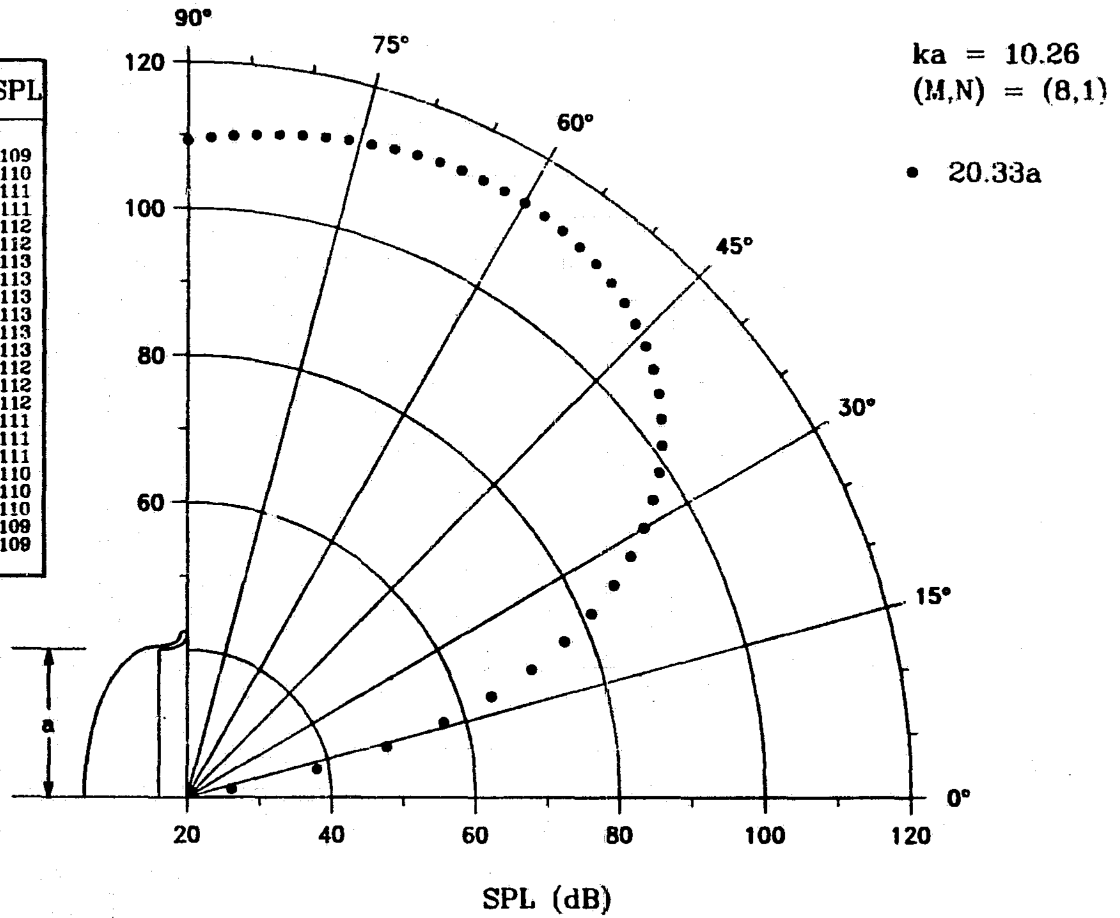


Fig. 23c

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	116
2	-74	48	117
4	-26	50	118
6	1	52	118
8	20	54	118
10	35	56	118
12	47	58	118
14	57	60	118
16	66	62	118
18	73	64	118
20	80	66	118
22	85	68	117
24	90	70	117
26	94	72	116
28	98	74	115
30	101	76	115
32	104	78	114
34	107	80	114
36	109	82	113
38	111	84	112
40	113	86	112
42	114	88	111
44	115	90	111

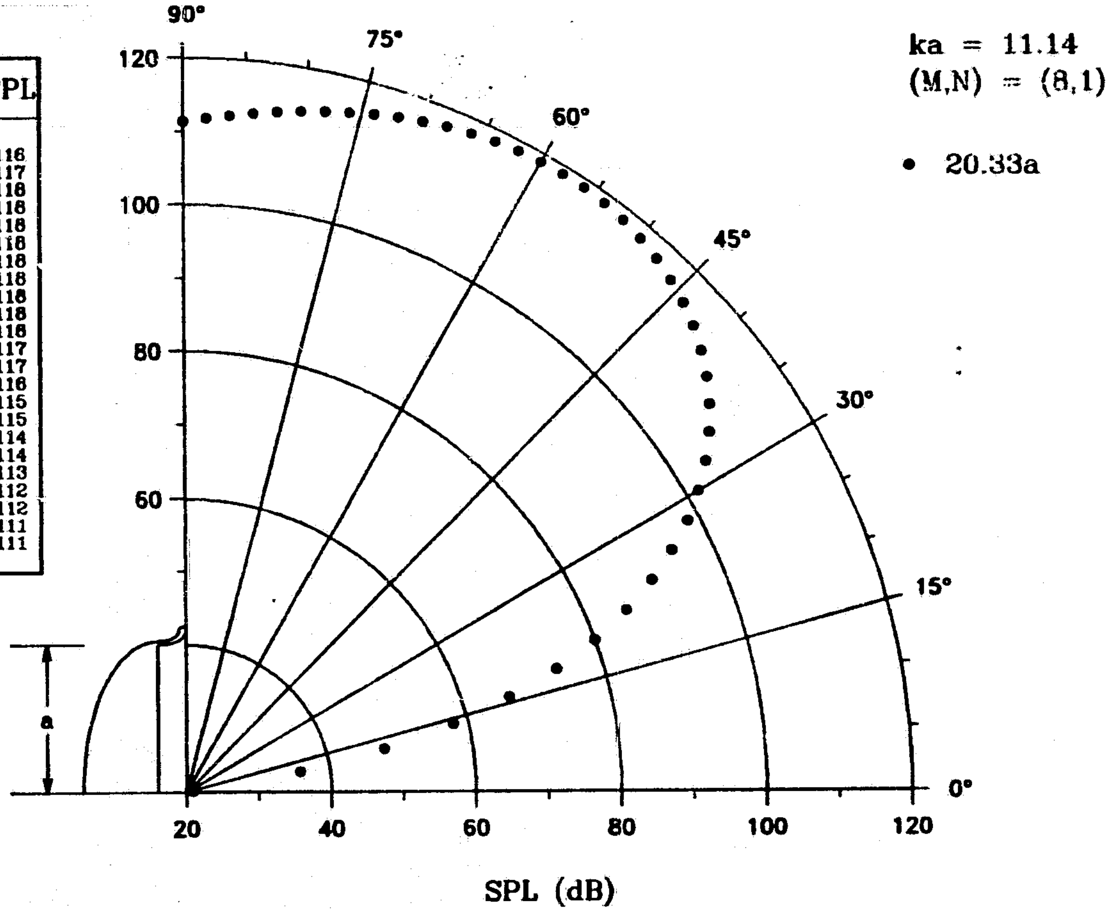


Fig. 23d

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	123
2	−63	48	123
4	−15	50	123
6	12	52	123
8	32	54	123
10	46	56	123
12	58	58	122
14	68	60	122
16	77	62	121
18	84	64	120
20	90	66	120
22	95	68	119
24	100	70	118
26	104	72	117
28	107	74	116
30	110	76	115
32	113	78	114
34	115	80	113
36	117	82	112
38	119	84	111
40	120	86	110
42	121	88	109
44	122	90	108

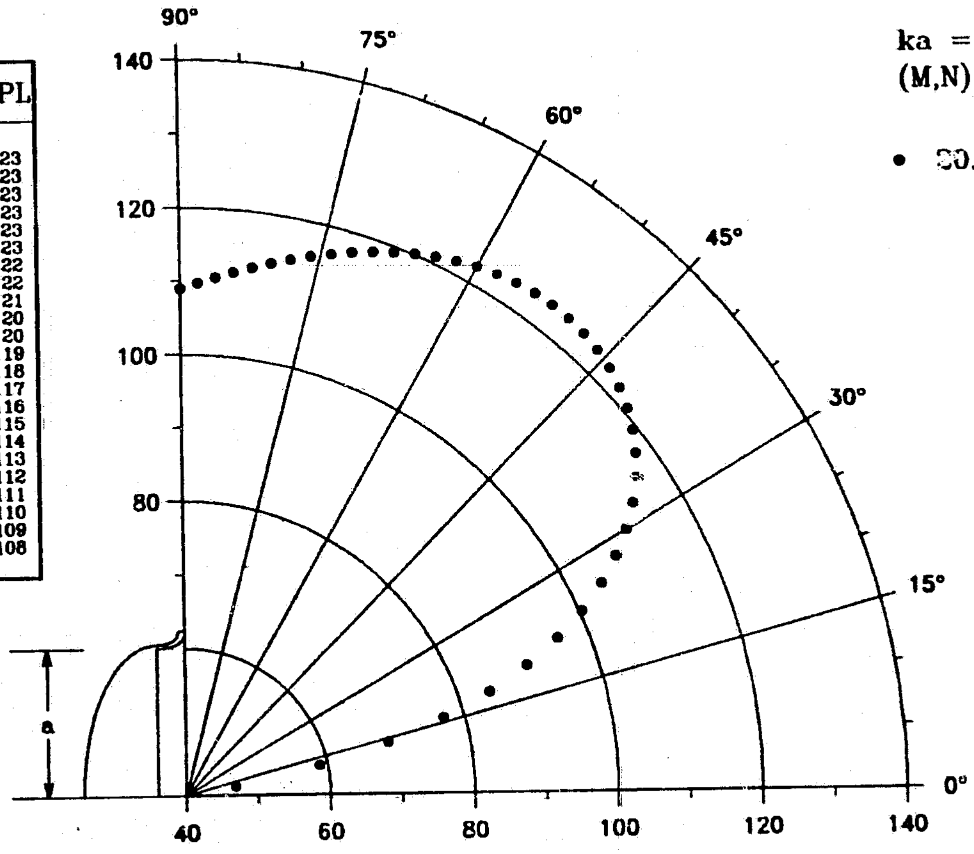


Fig. 23e

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	127
2	-48	48	127
4	0	50	126
6	27	52	124
8	46	54	123
10	61	56	121
12	73	58	119
14	82	60	117
16	90	62	114
18	97	64	111
20	103	66	109
22	108	68	108
24	112	70	108
26	116	72	108
28	119	74	109
30	121	76	109
32	123	78	109
34	125	80	109
36	126	82	109
38	127	84	108
40	128	86	108
42	128	88	108
44	128	90	107

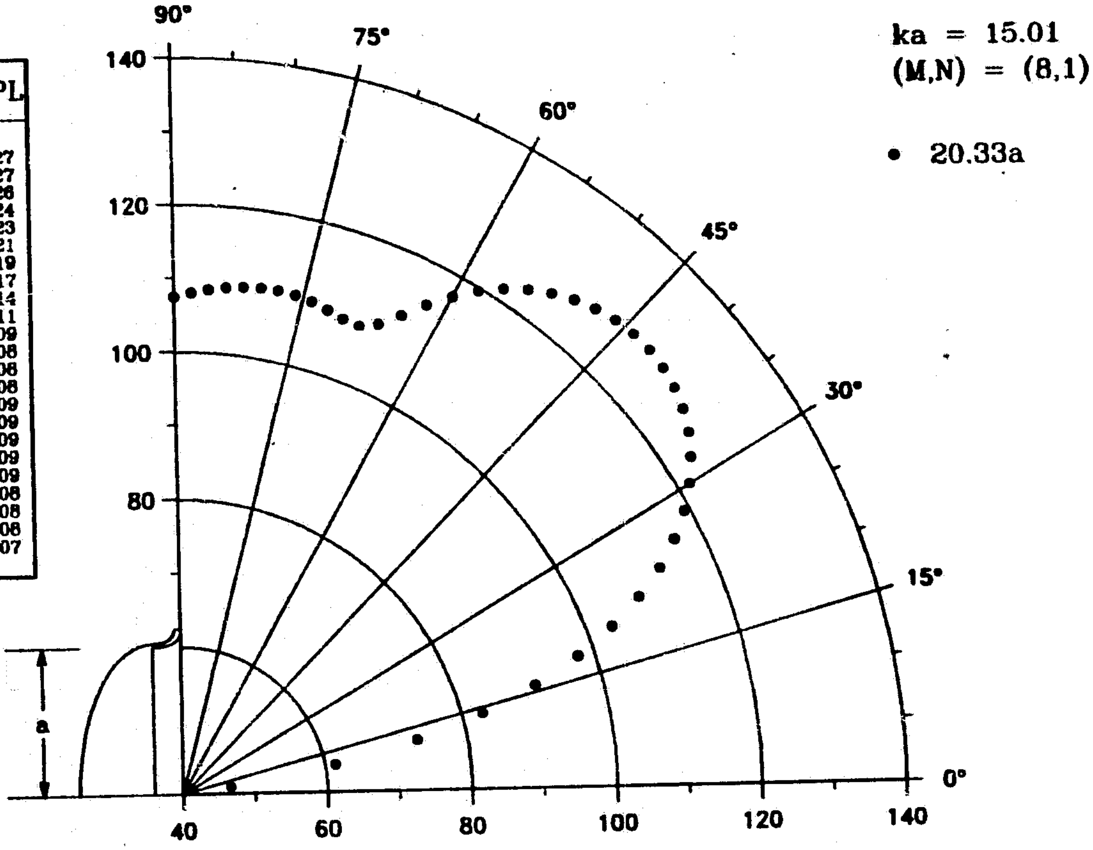


Fig. 23f

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	106
2	44	48	101
4	67	50	101
6	81	52	106
8	90	54	110
10	97	56	113
12	102	58	114
14	106	60	116
16	108	62	116
18	110	64	117
20	112	66	117
22	112	68	117
24	111	70	117
26	110	72	116
28	107	74	116
30	101	76	115
32	98	78	115
34	104	80	114
36	108	82	113
38	110	84	113
40	111	86	112
42	110	88	111
44	109	90	110

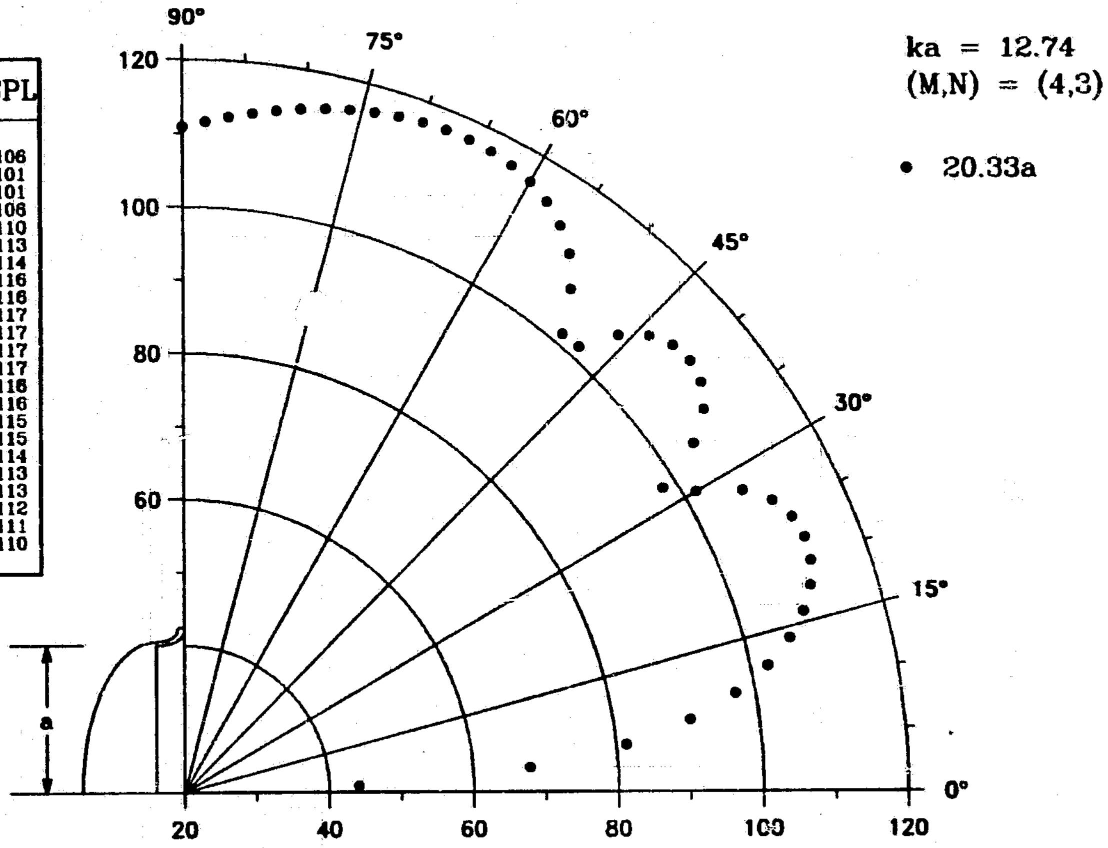
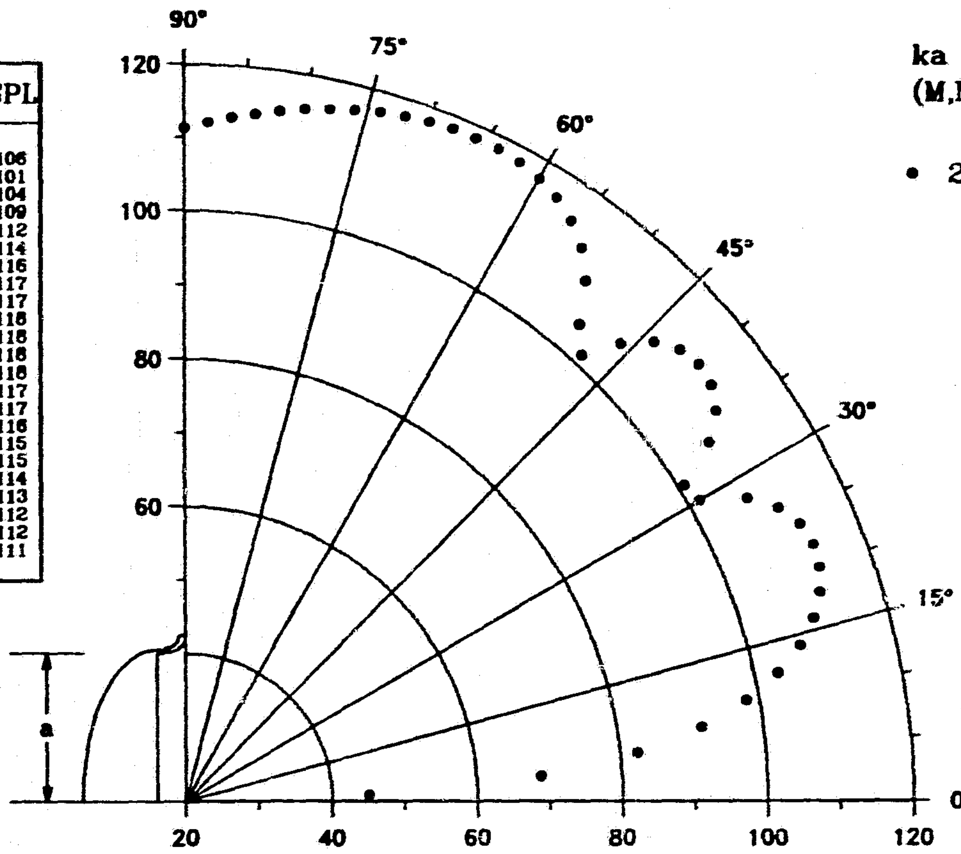


Fig. 24a

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	106
2	45	48	101
4	68	50	104
6	82	52	109
8	91	54	112
10	98	56	114
12	103	58	116
14	107	[illegible]	117
16	109	62	117
18	111	64	118
20	112	66	118
22	113	68	118
24	112	70	118
26	110	72	117
28	107	74	117
30	101	76	116
32	100	78	115
34	106	80	115
36	110	82	114
38	111	84	113
40	112	86	112
42	111	88	112
44	109	90	111



ka = 12.87
(M,N) = (4,3)

• 20.33a

Fig. 24b

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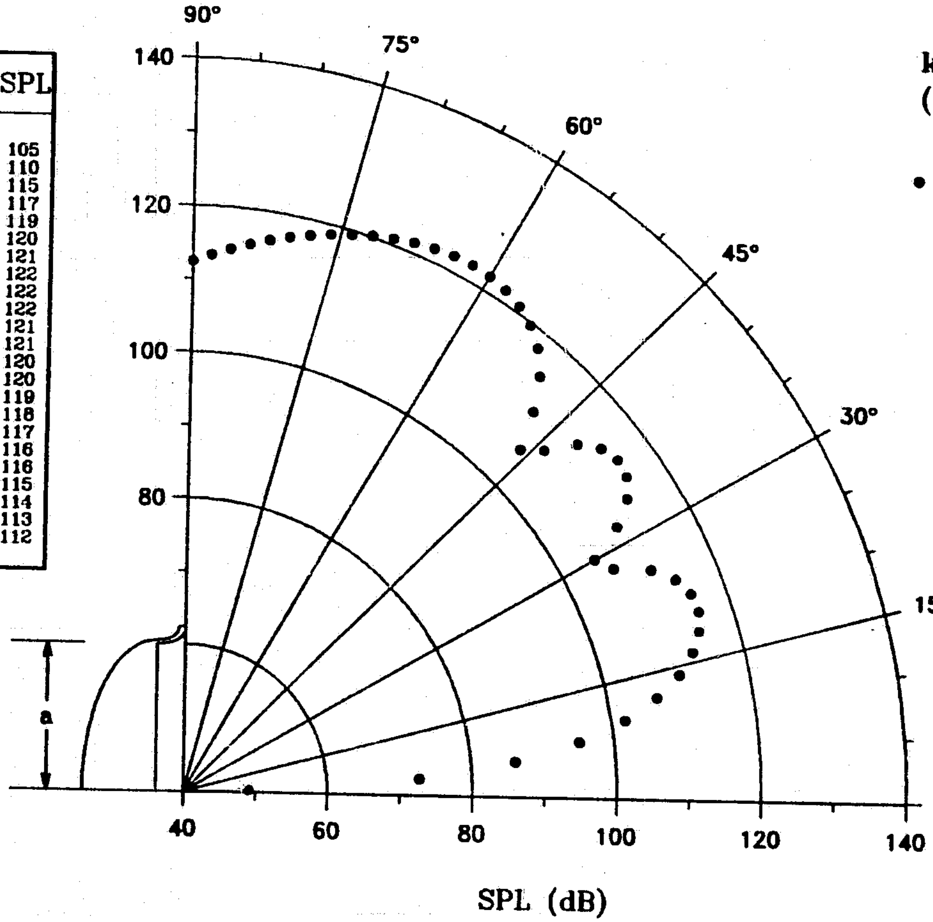
THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	105
2	48	48	110
4	72	50	115
6	86	52	117
8	95	54	119
10	101	56	120
12	106	58	121
14	110	60	122
16	112	62	122
18	114	64	122
20	115	66	121
22	115	68	121
24	113	70	120
26	111	72	120
28	106	74	119
30	105	76	118
32	109	78	117
34	113	80	116
36	114	82	116
38	115	84	115
40	114	86	114
42	112	88	113
44	108	90	112



ka = 13.49
(M,N) = (4,3)

• 20.33a

Fig. 24c

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	120
2	53	48	122
4	76	50	124
6	90	52	125
8	99	54	126
10	105	56	126
12	110	58	126
14	113	60	125
16	115	62	125
18	116	64	124
20	116	66	123
22	115	68	122
24	112	70	121
26	108	72	120
28	110	74	119
30	114	76	117
32	116	78	116
34	117	80	115
36	116	82	114
38	114	84	113
40	110	86	112
42	111	88	111
44	116	90	110

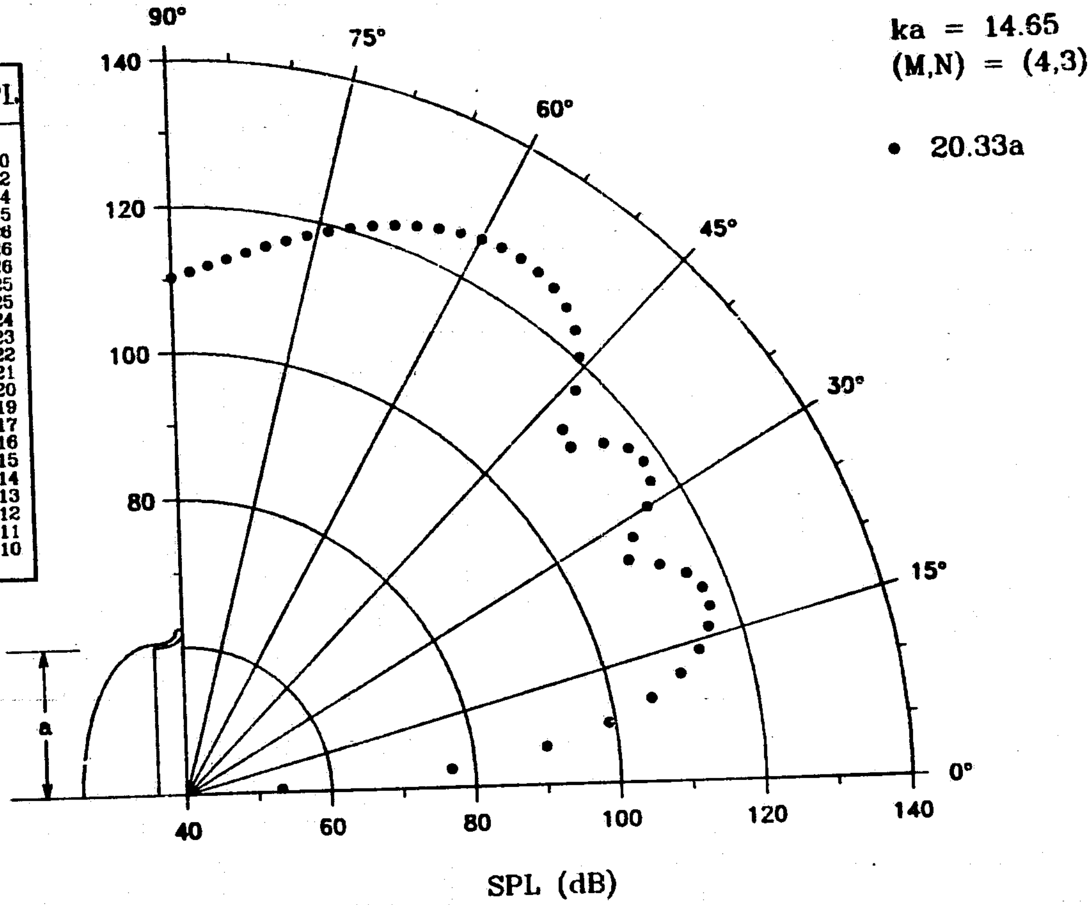


Fig. 24d

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	129
2	58	48	130
4	82	50	130
6	95	52	129
8	104	54	128
10	110	56	127
12	114	58	126
14	116	60	124
16	117	62	122
18	117	64	119
20	115	66	117
22	111	68	114
24	112	70	112
26	116	72	109
28	119	74	108
30	119	76	108
32	118	78	108
34	115	80	108
36	114	82	108
38	120	84	108
40	124	86	107
42	127	88	107
44	128	90	107

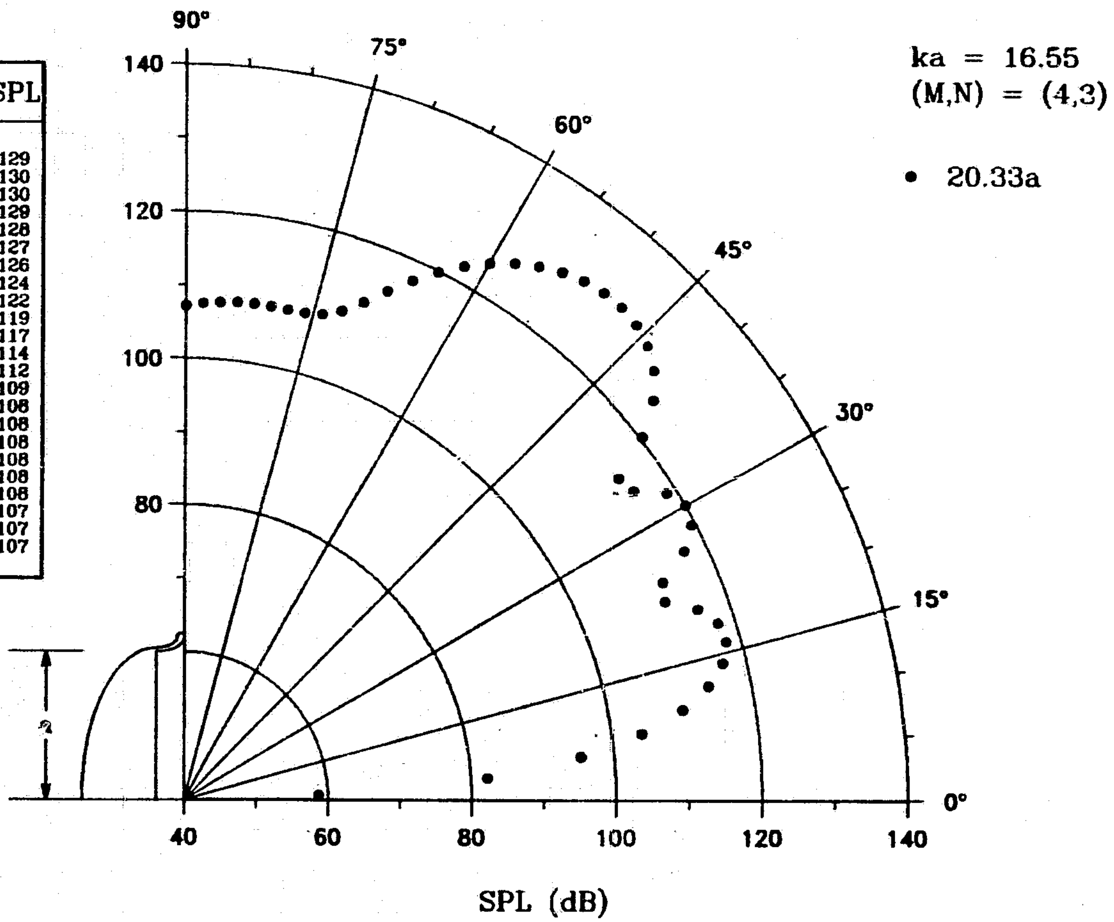
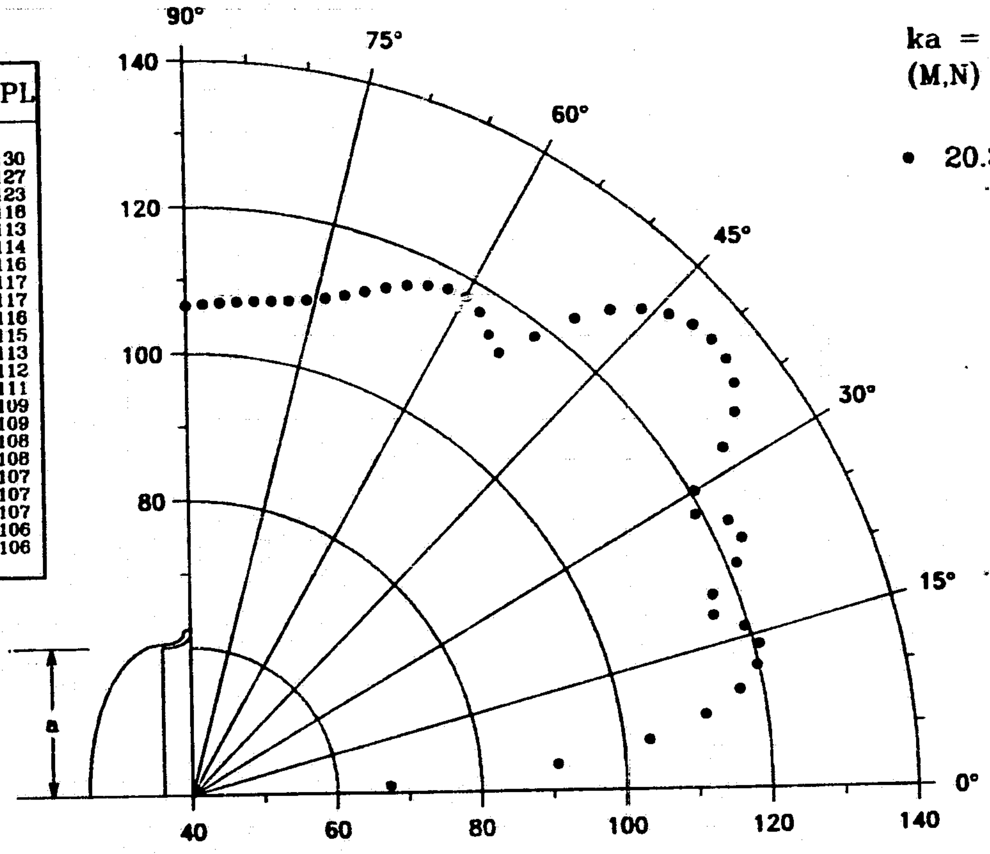


Fig. 24e

THIN LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	130
2	67	48	127
4	90	50	123
6	103	52	118
8	111	54	113
10	116	56	114
12	119	58	116
14	120	60	117
16	119	62	117
18	115	64	116
20	116	66	115
22	121	68	113
24	123	70	112
26	122	72	111
28	119	74	109
30	120	76	109
32	127	78	108
34	131	80	108
36	133	82	107
38	134	84	107
40	134	86	107
42	134	88	106
44	132	90	106



ka = 19.73
(M,N) = (4,3)

• 20.33a

Fig. 24f

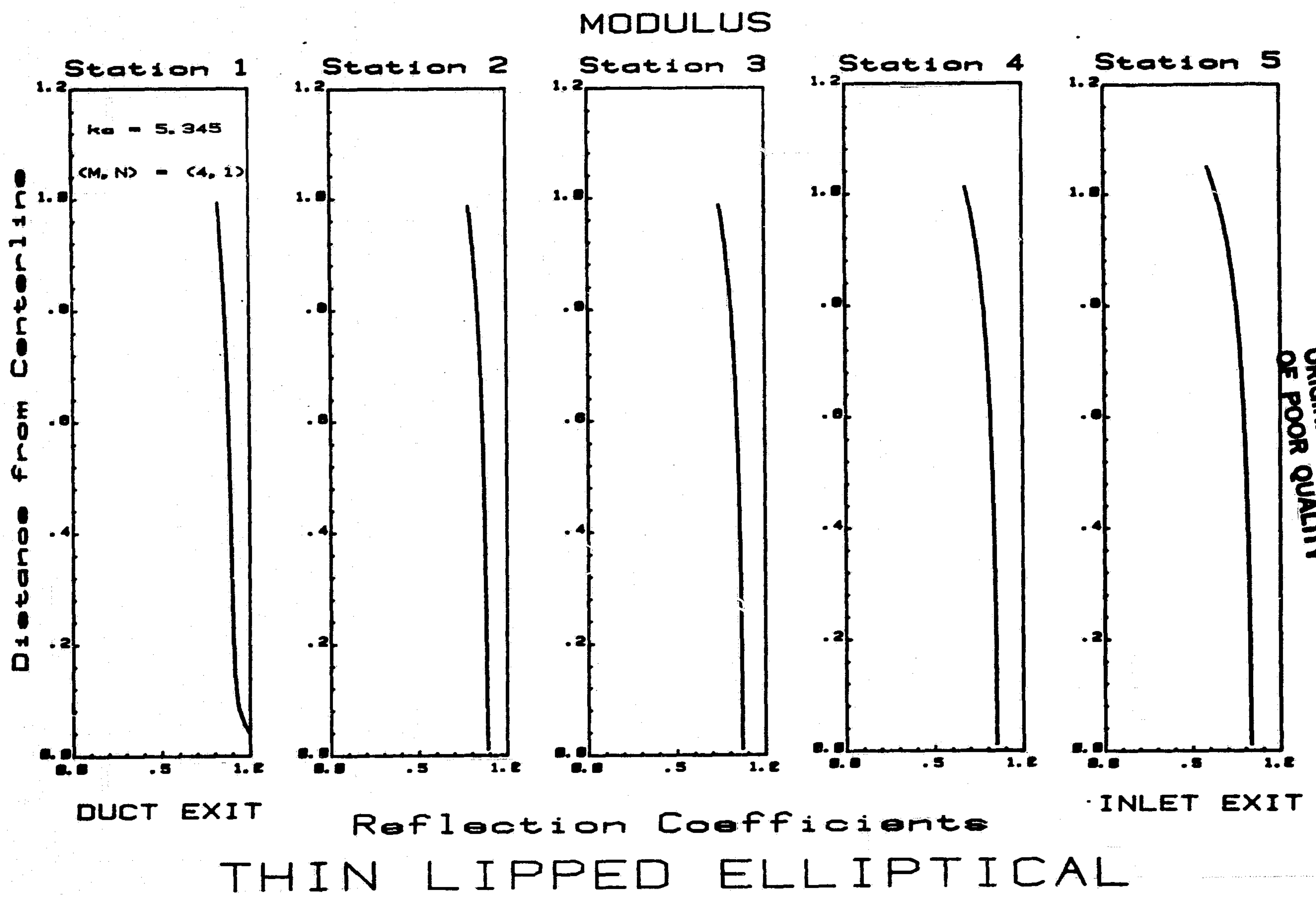


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Fig. 25a

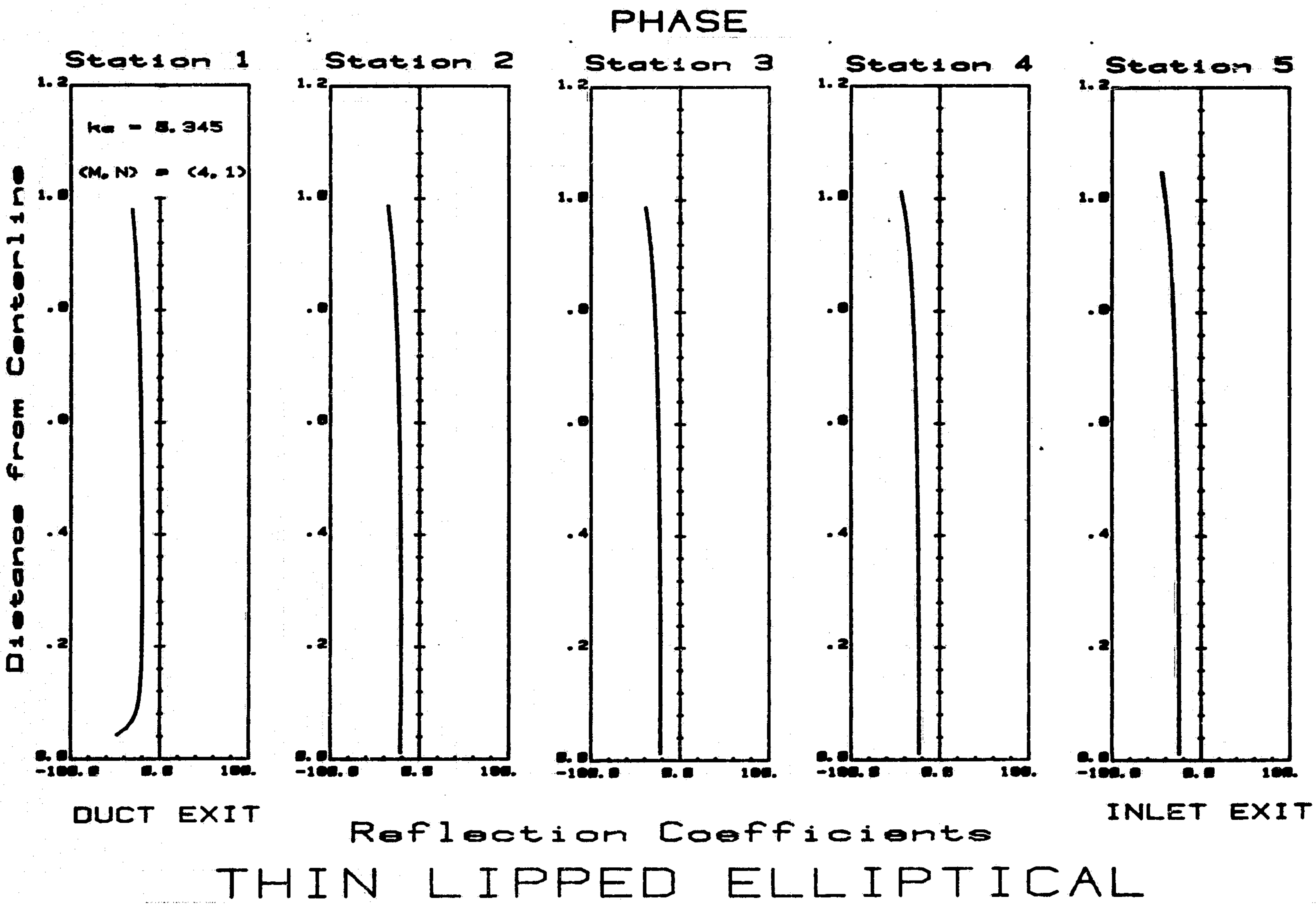
PHASE
Station 1
Station 2
Station 3
Station 4
Station 5
ke = 8.345
(M, N) = (4, 1)
Distance from Centerline
1.2
1.0
.8
.6
.4
.2
0.0
-100.0
0.0
100.
DUCT EXIT
INLET EXIT
Reflection Coefficients
THIN LIPPED ELLIPTICAL

Fig. 25b

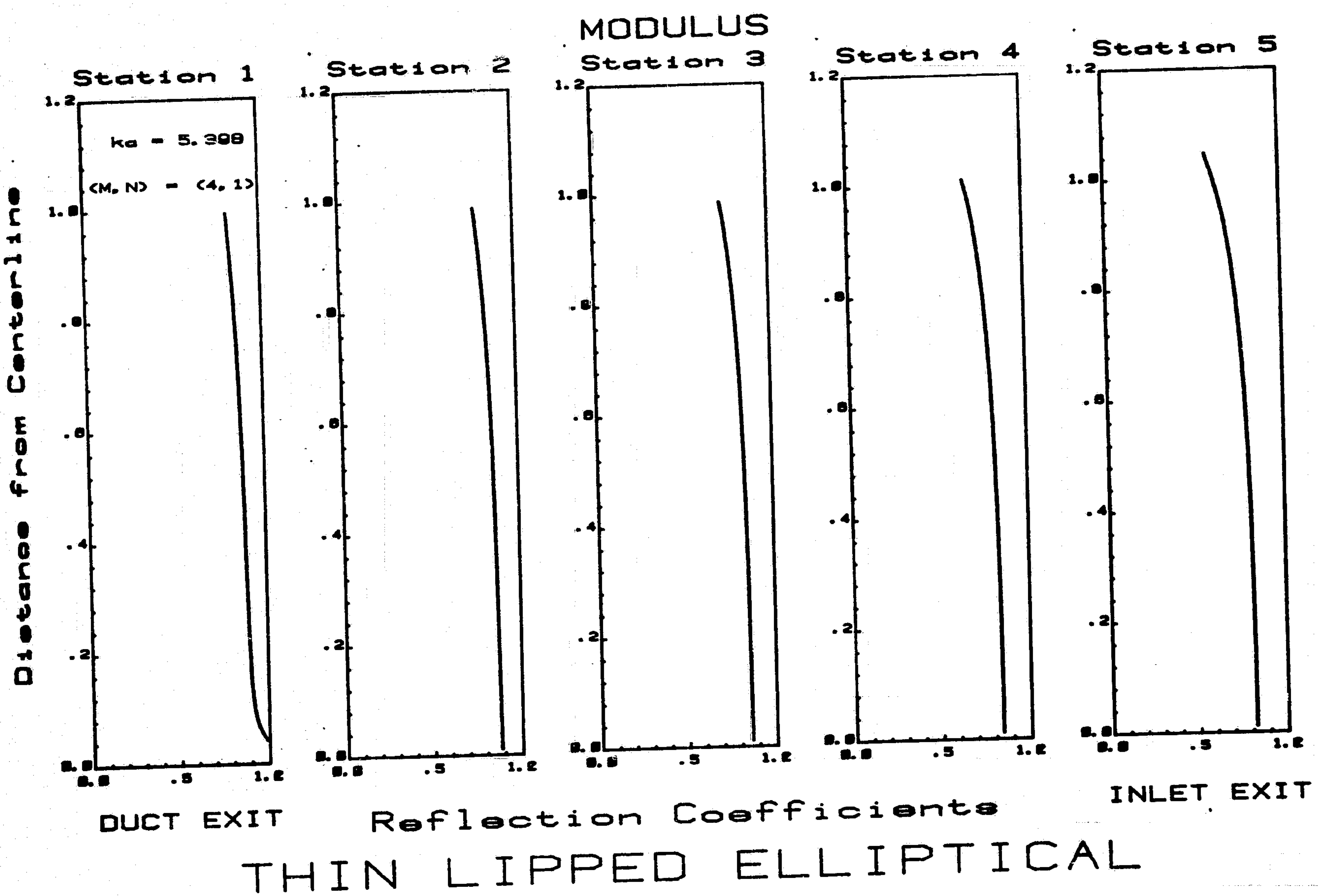
MODULUS
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 5.300
(M, N) = (4, 1)
Distance from Centerline
0.0
.2
.4
.6
.8
1.0
1.2
.5
DUCT EXIT
Reflection Coefficients
INLET EXIT
THIN LIPPED ELLIPTICAL

Fig. 25c

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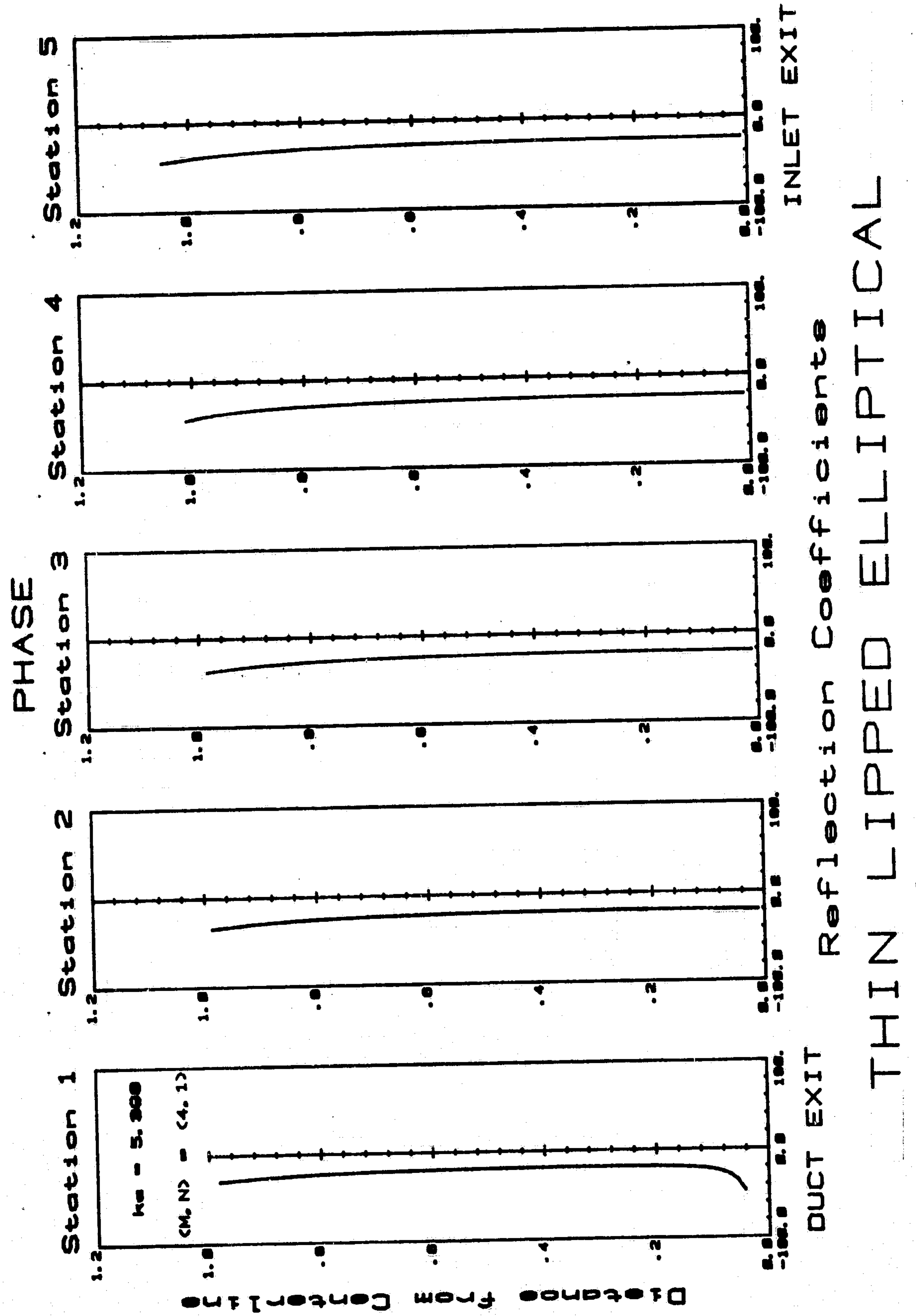

Fig. 25d

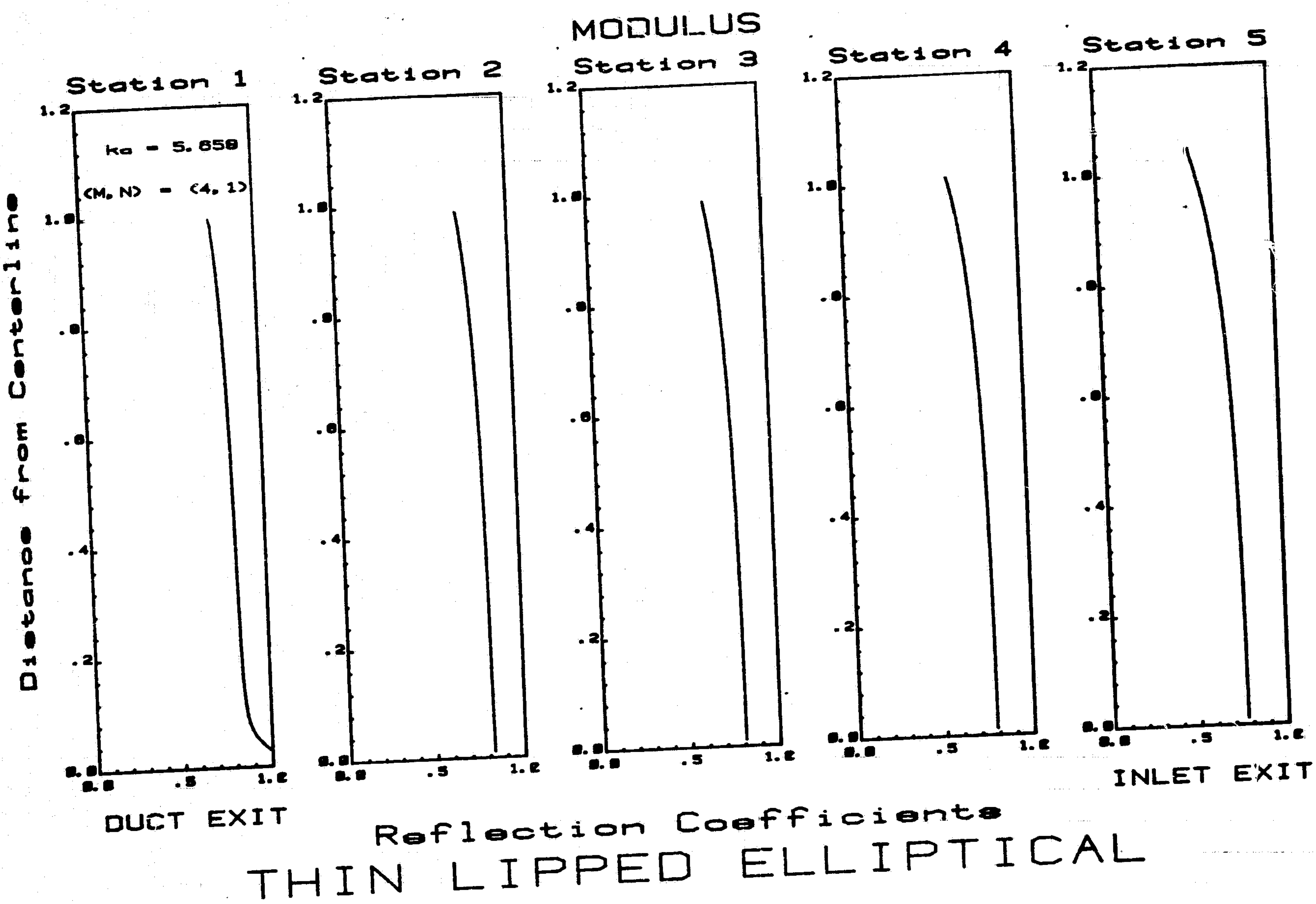
MODULUS
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 5.650
(M, N) = (4, 1)
Distance from Centerline
DUCT EXIT
INLET EXIT
Reflection Coefficients
THIN LIPPED ELLIPTICAL

Fig. 25e

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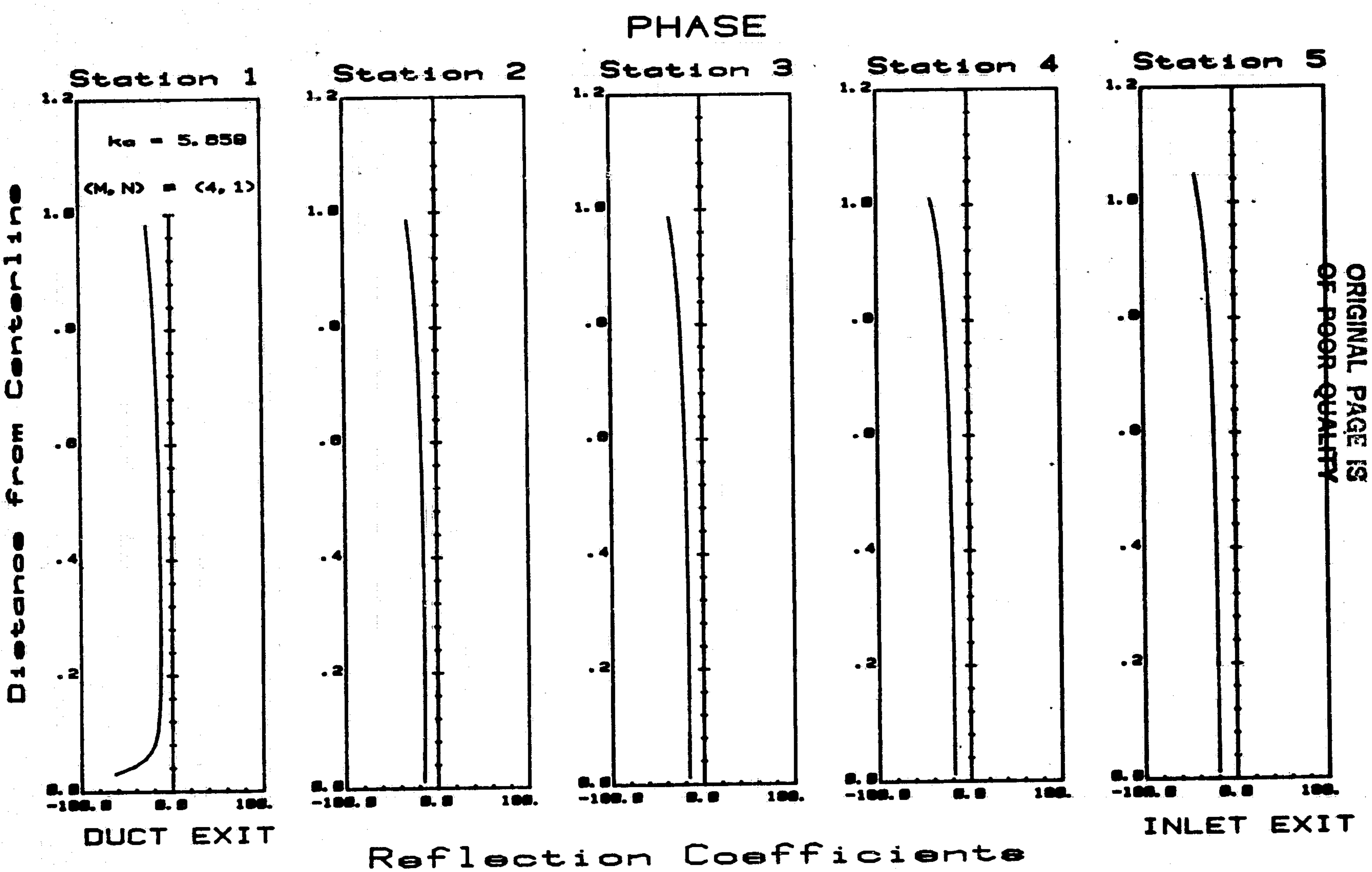


THIN LIPPED ELLIPTICAL

Fig. 25f

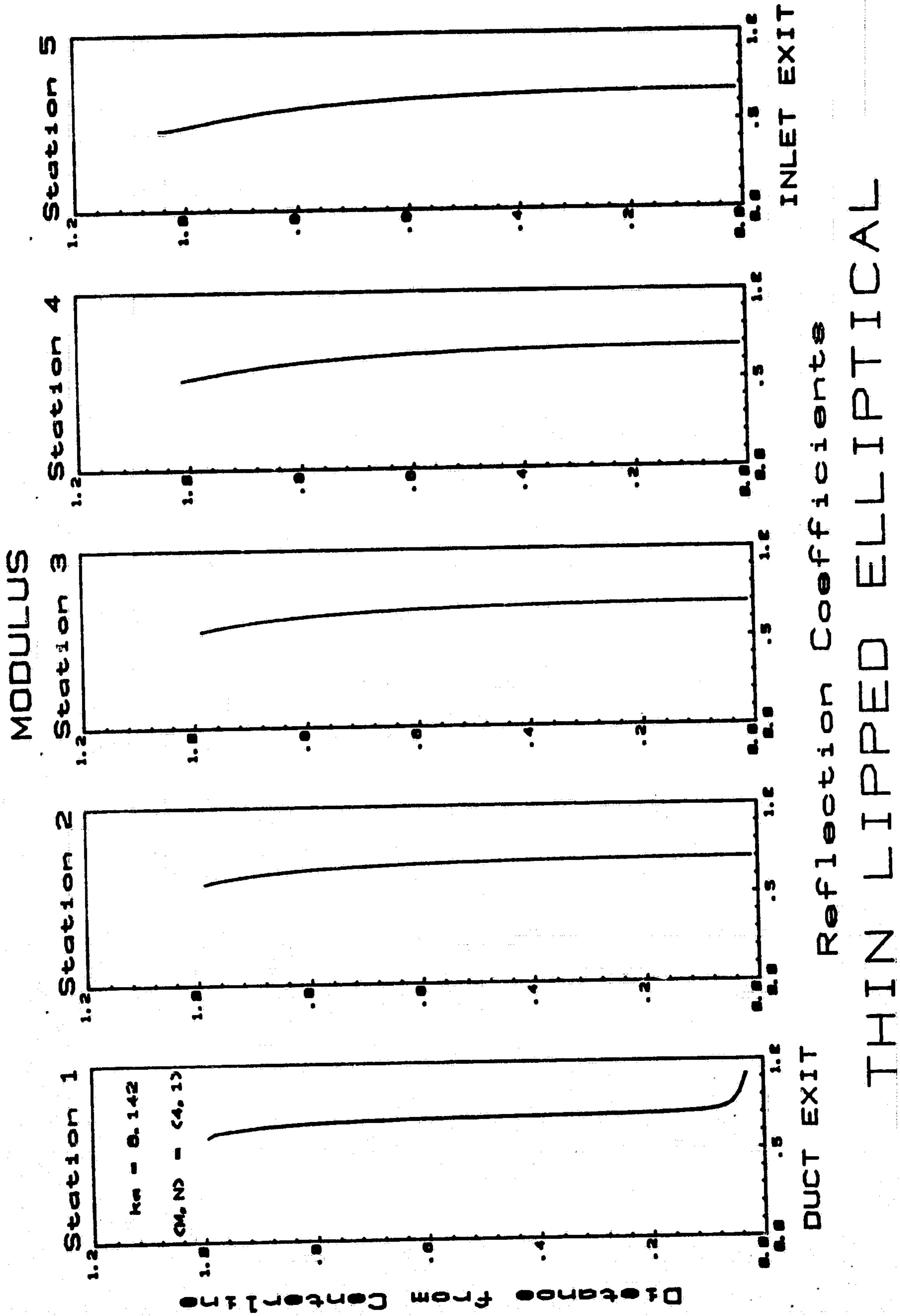

MODULUS
Reflection Coefficients
THIN LIPPED ELLIPTICAL
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 0.142
(M,N) = (4,1)
DUCT EXIT
INLET EXIT
Distance from Centerline

Fig. 25g

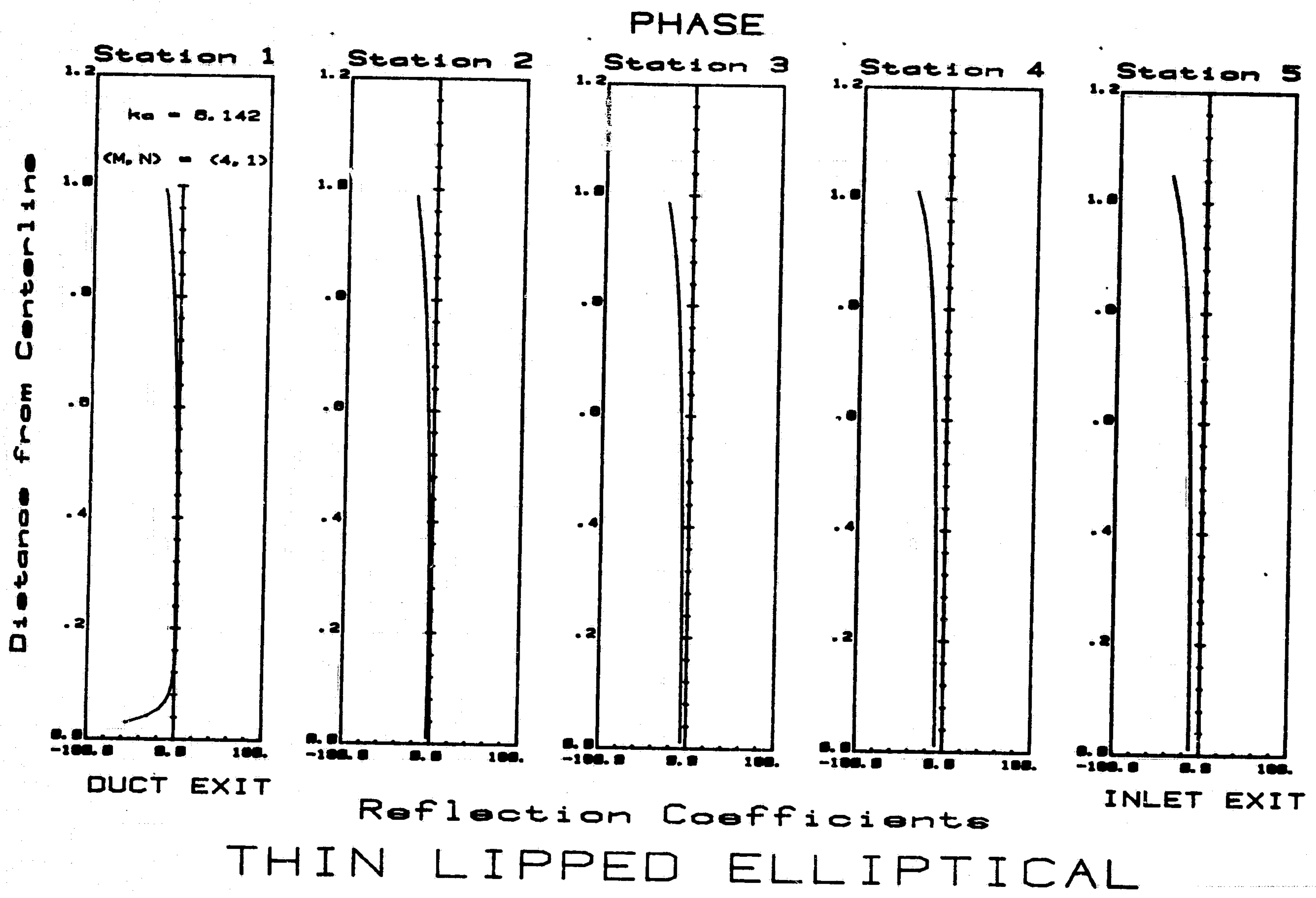
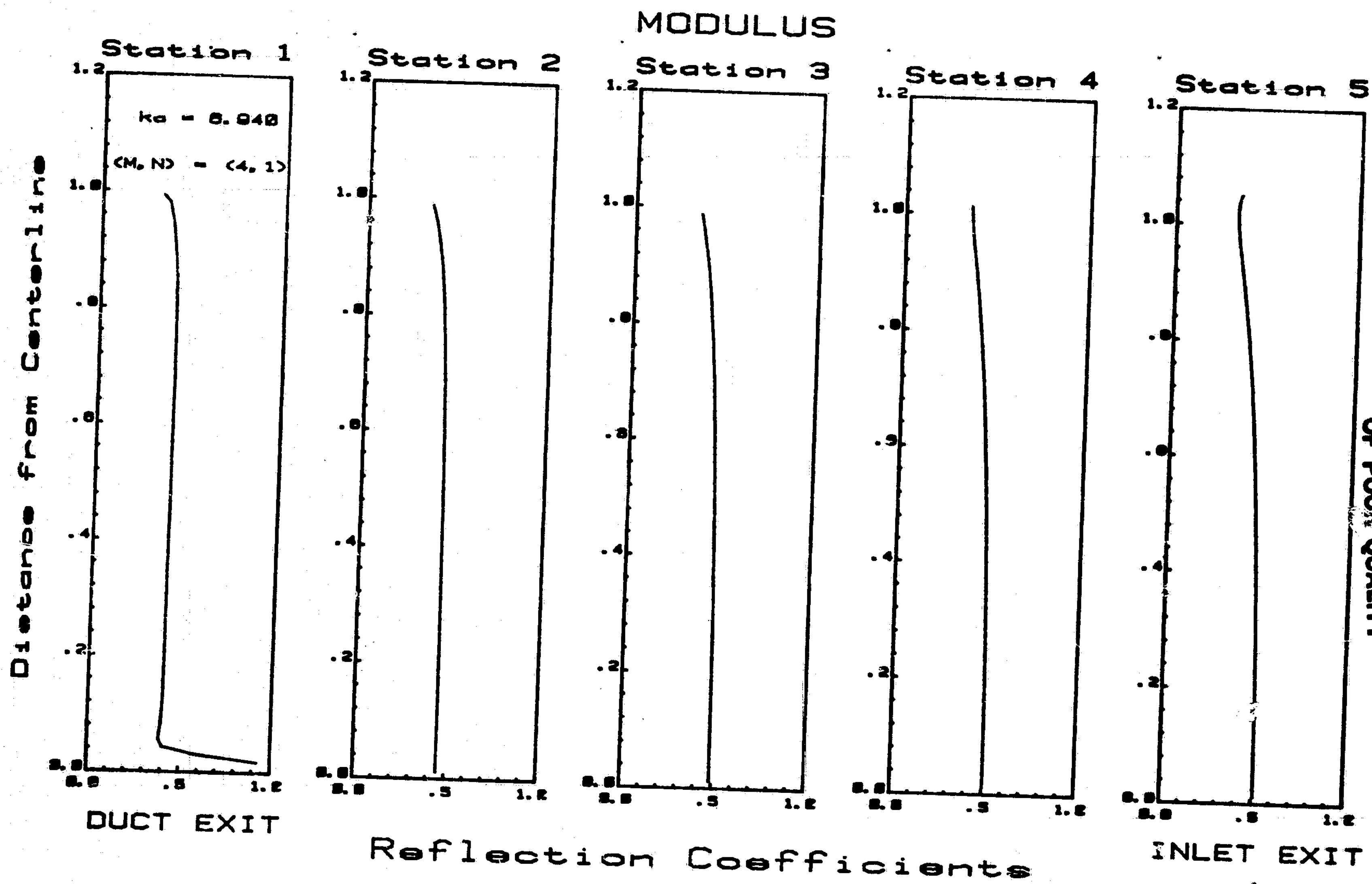
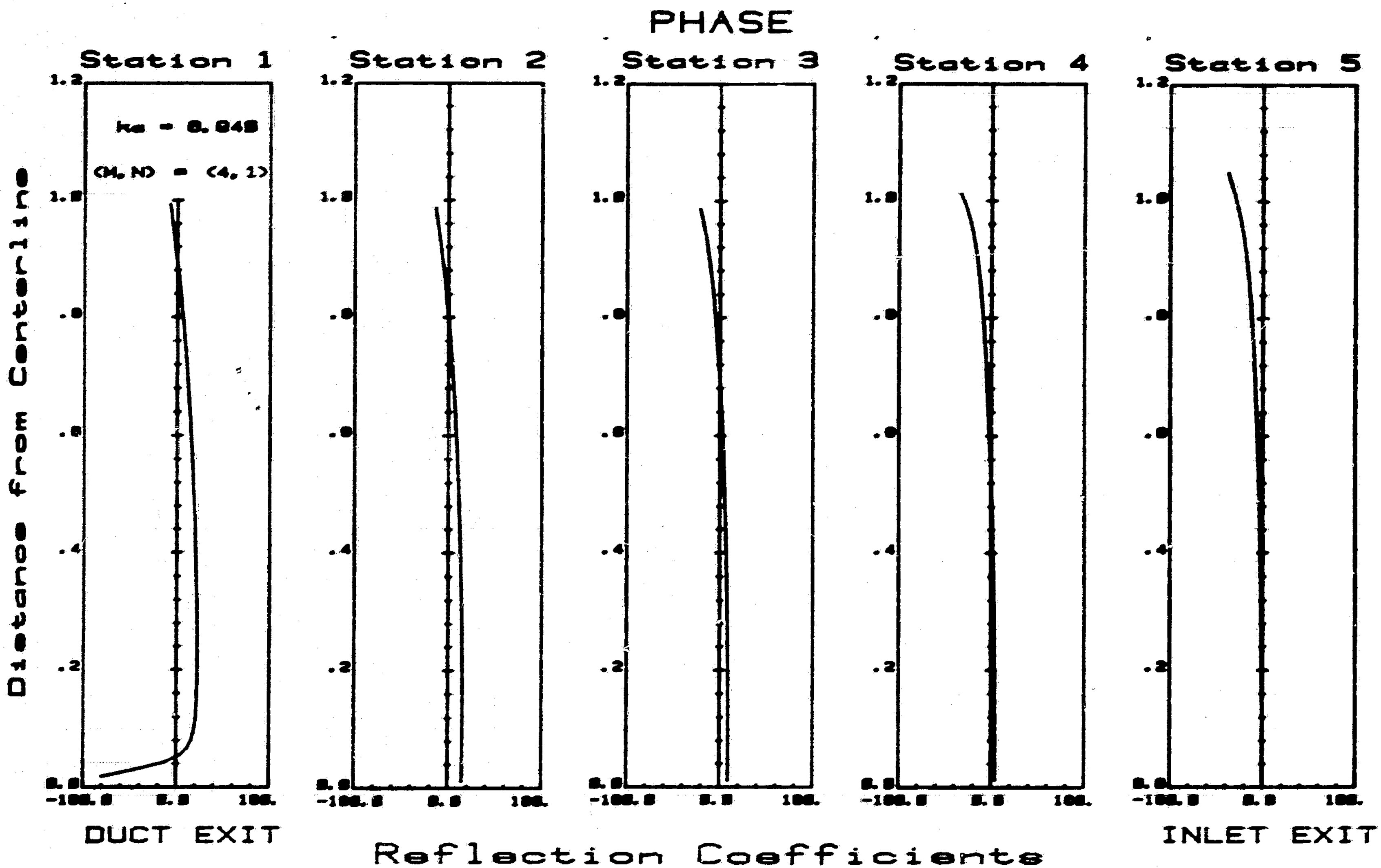

PHASE
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 8.142
(M, N) = (4, 1)
Distance from Centerline
1.2
1.0
.8
.6
.4
.2
0.0
-100.0
0.0
100.
DUCT EXIT
INLET EXIT
Reflection Coefficients
THIN LIPPED ELLIPTICAL

Fig. 25h



THIN LIPPED ELLIPTICAL

Fig, 25i



THIN LIPPED ELLIPTICAL

Fig. 25j

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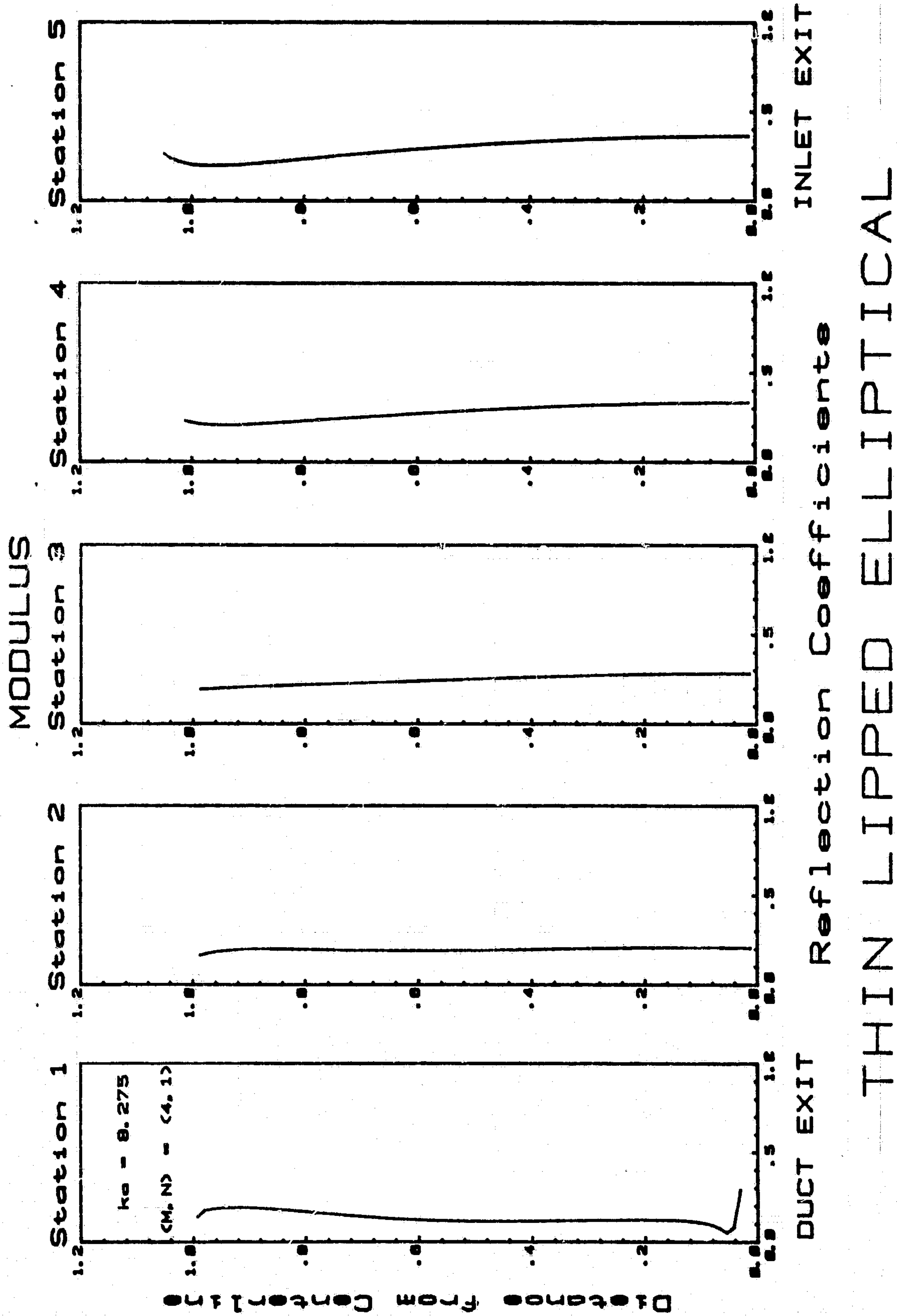
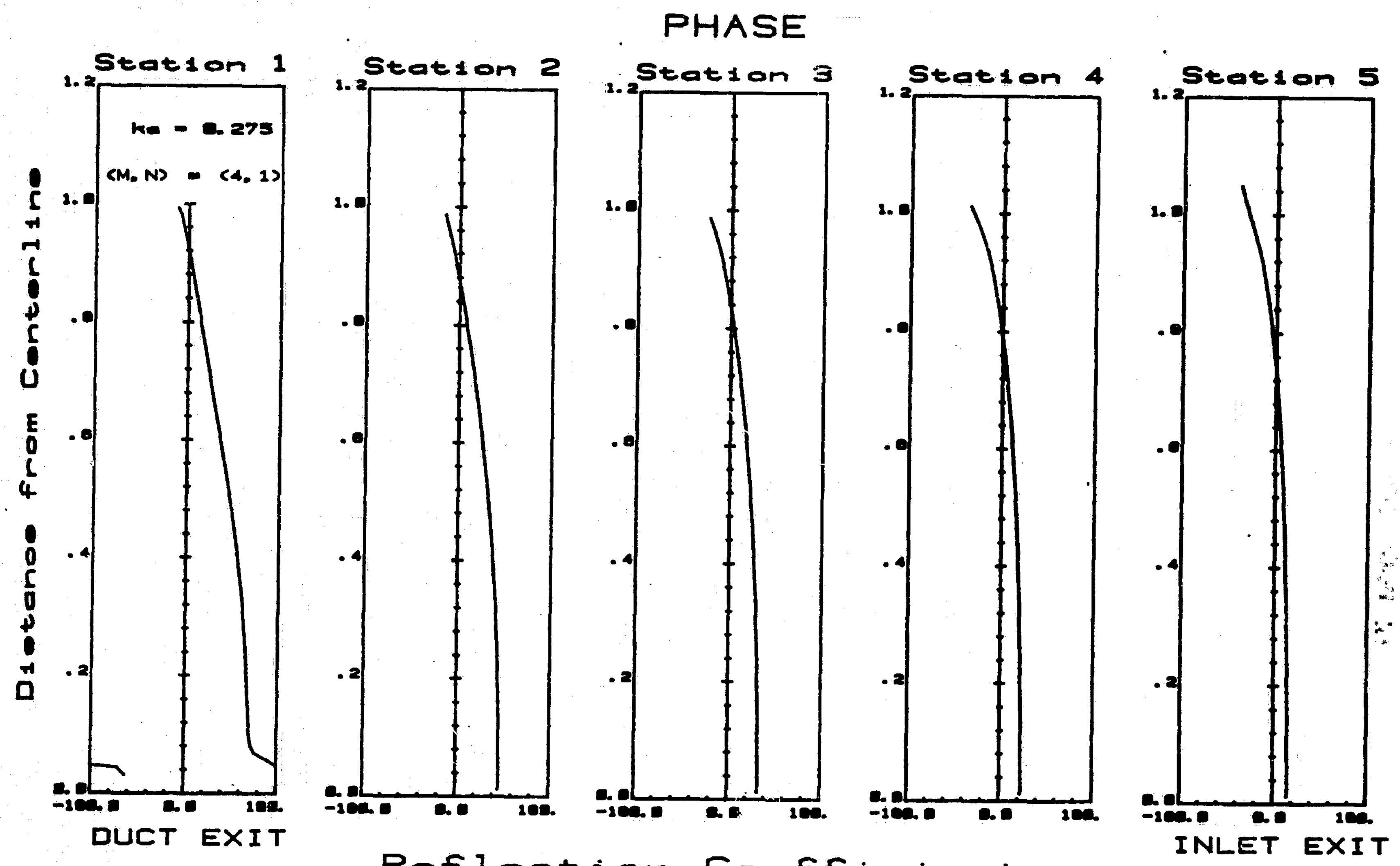


Fig. 25k



THIN LIPPED ELLIPTICAL

Fig. 251

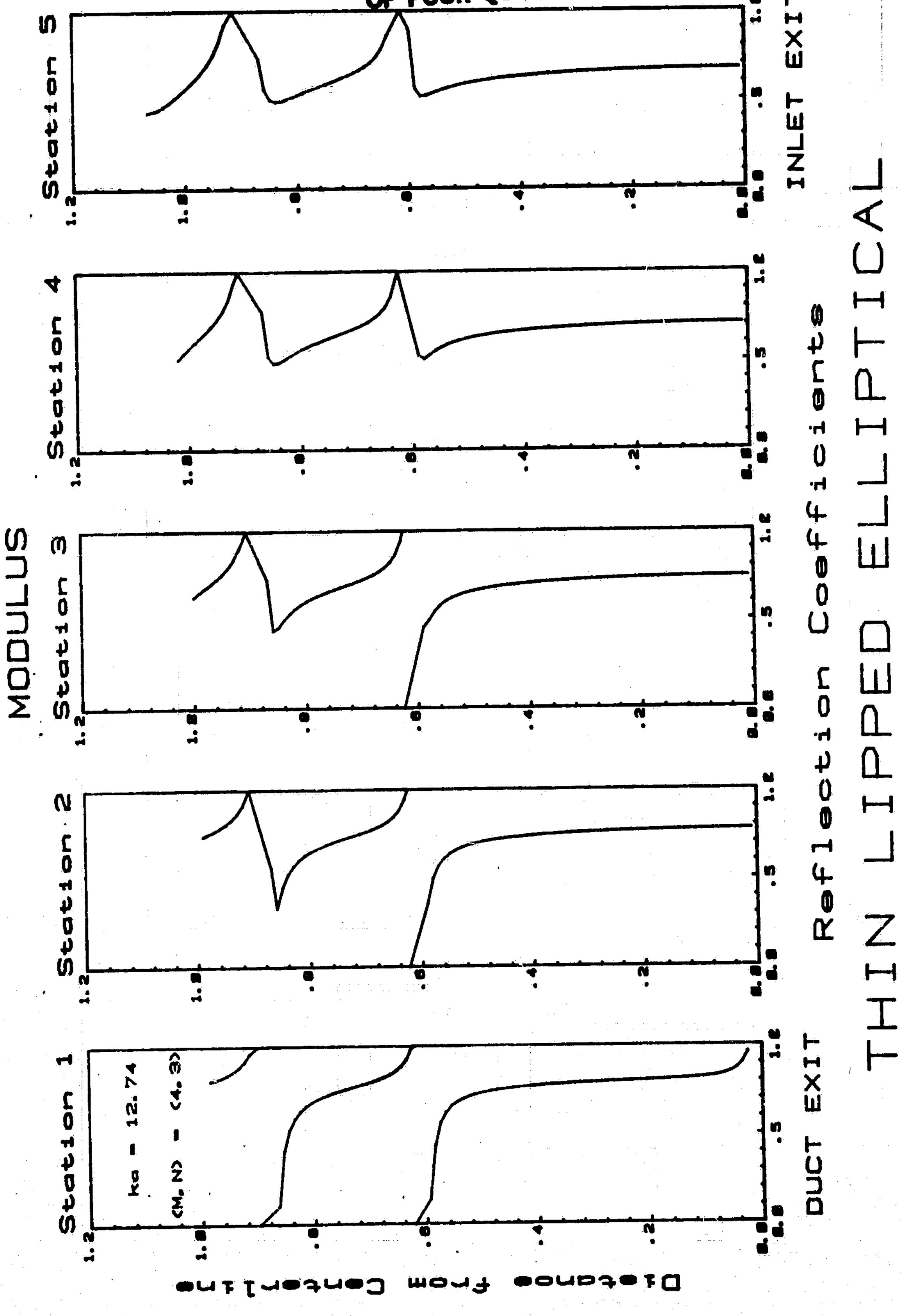
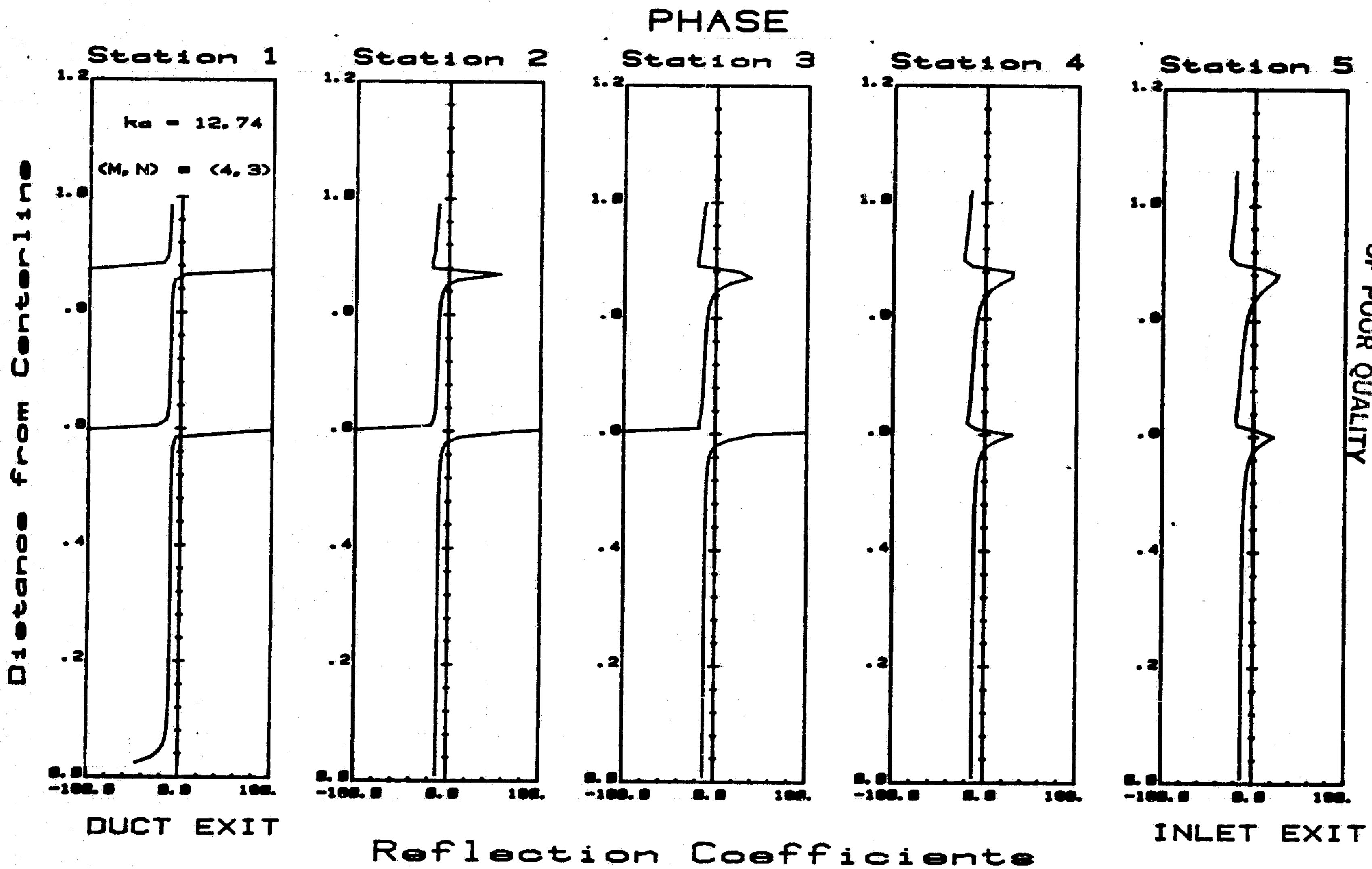

MODULUS
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 12.74
(M, N) = (4, 3)
DUCT EXIT
INLET EXIT
Reflection Coefficients
Distance from Centerline
THIN LIPPED ELLIPTICAL

Fig. 26a



THIN LIPPED ELLIPTICAL

Fig. 26b

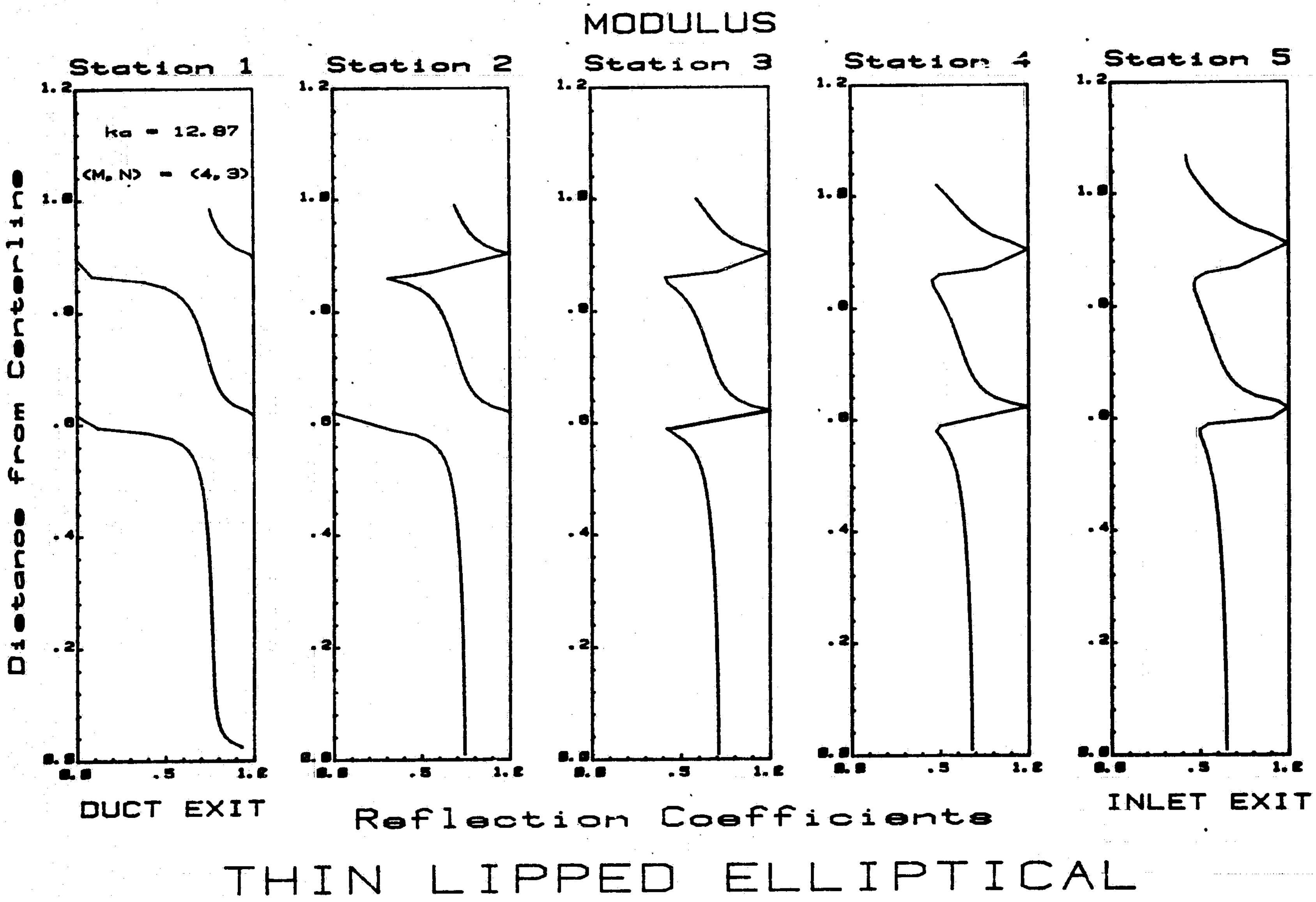


Fig.26c

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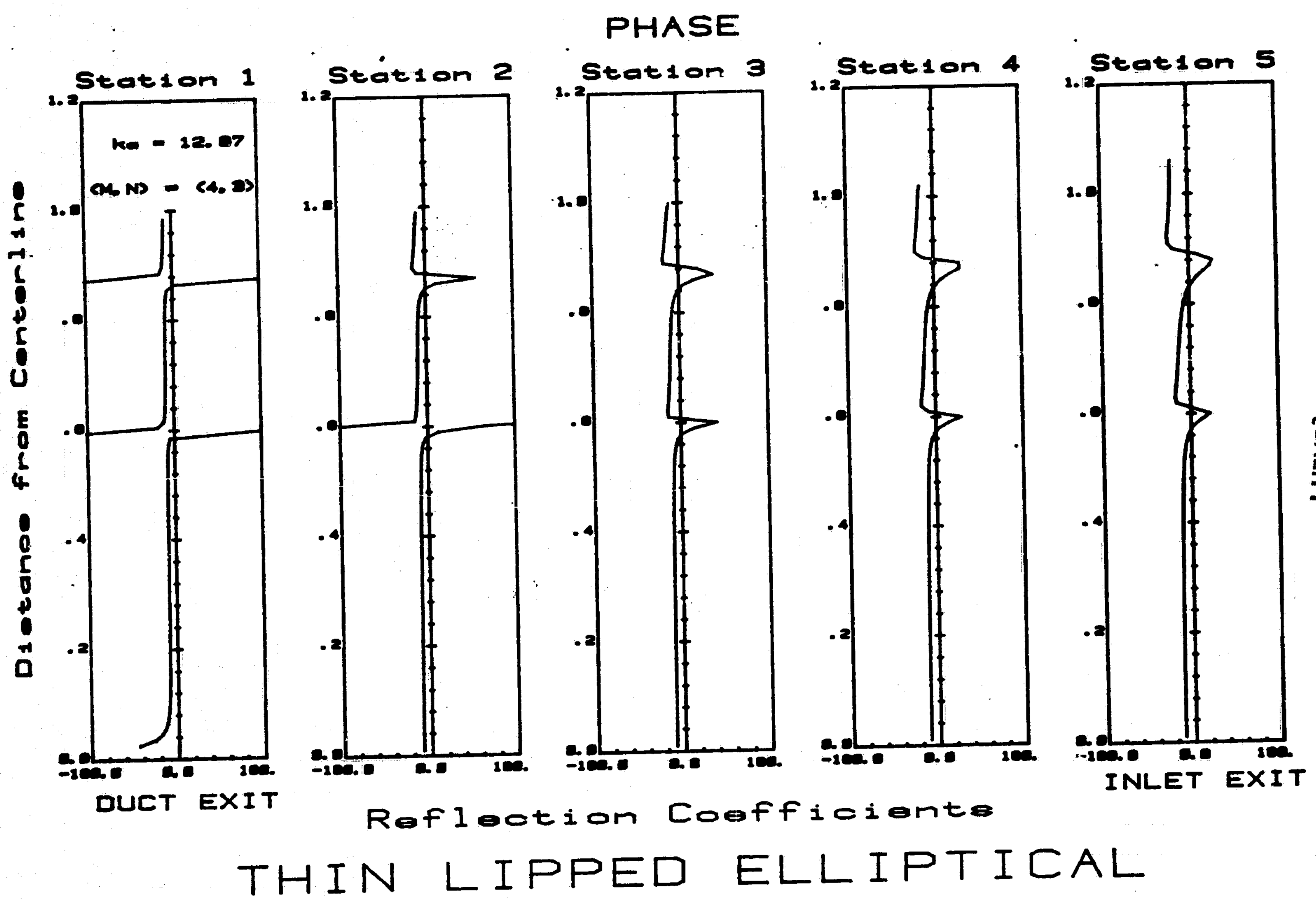
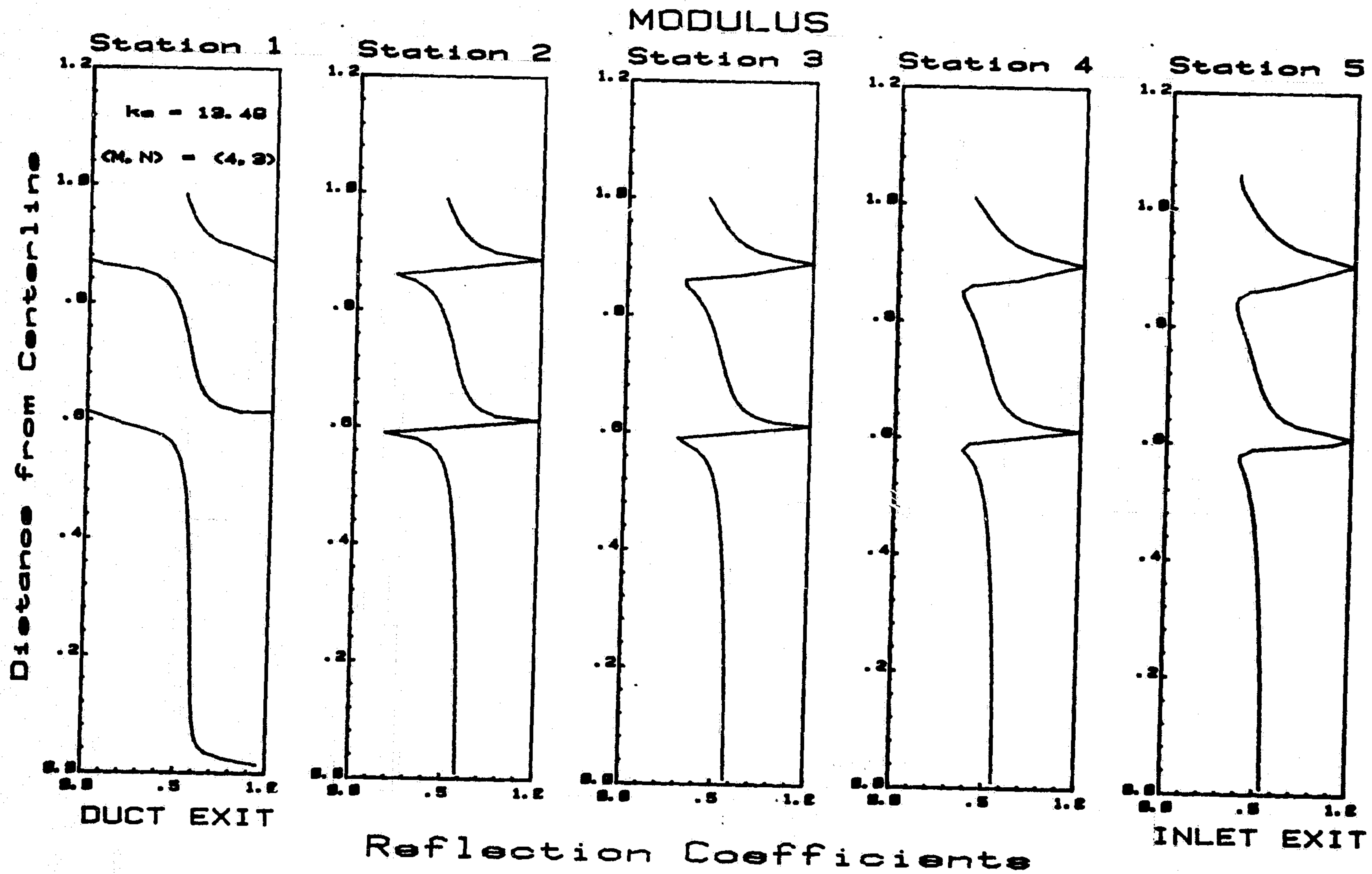
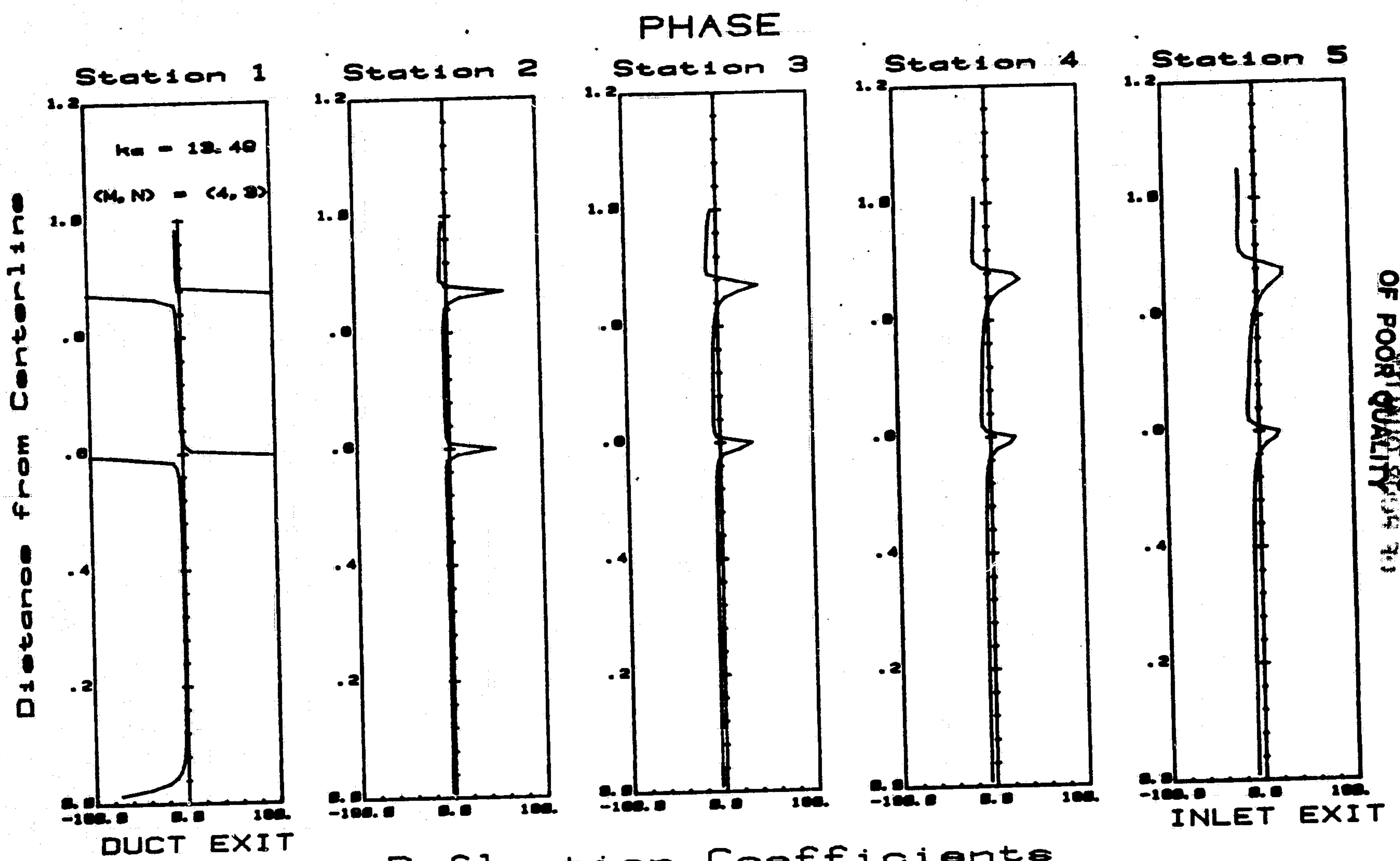

PHASE
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 12.87
(M, N) = (4, 3)
Distance from Centerline
Reflection Coefficients
DUCT EXIT
INLET EXIT
THIN LIPPED ELLIPTICAL

Fig. 26d



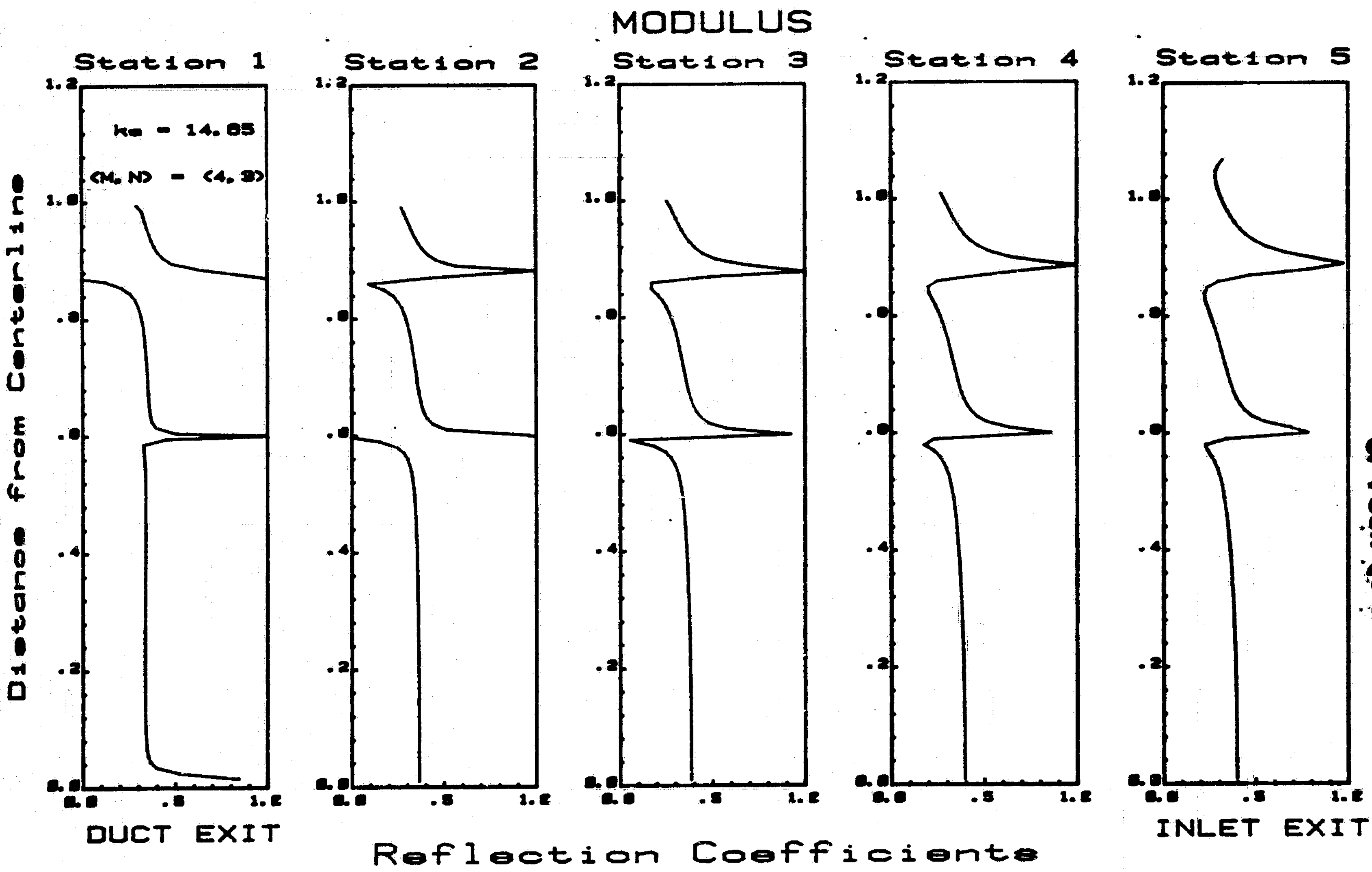
THIN LIPPED ELLIPTICAL

Fig. 26e



THIN LIPPED ELLIPTICAL

Fig. 26f



THIN LIPPED ELLIPTICAL

Fig. 26g

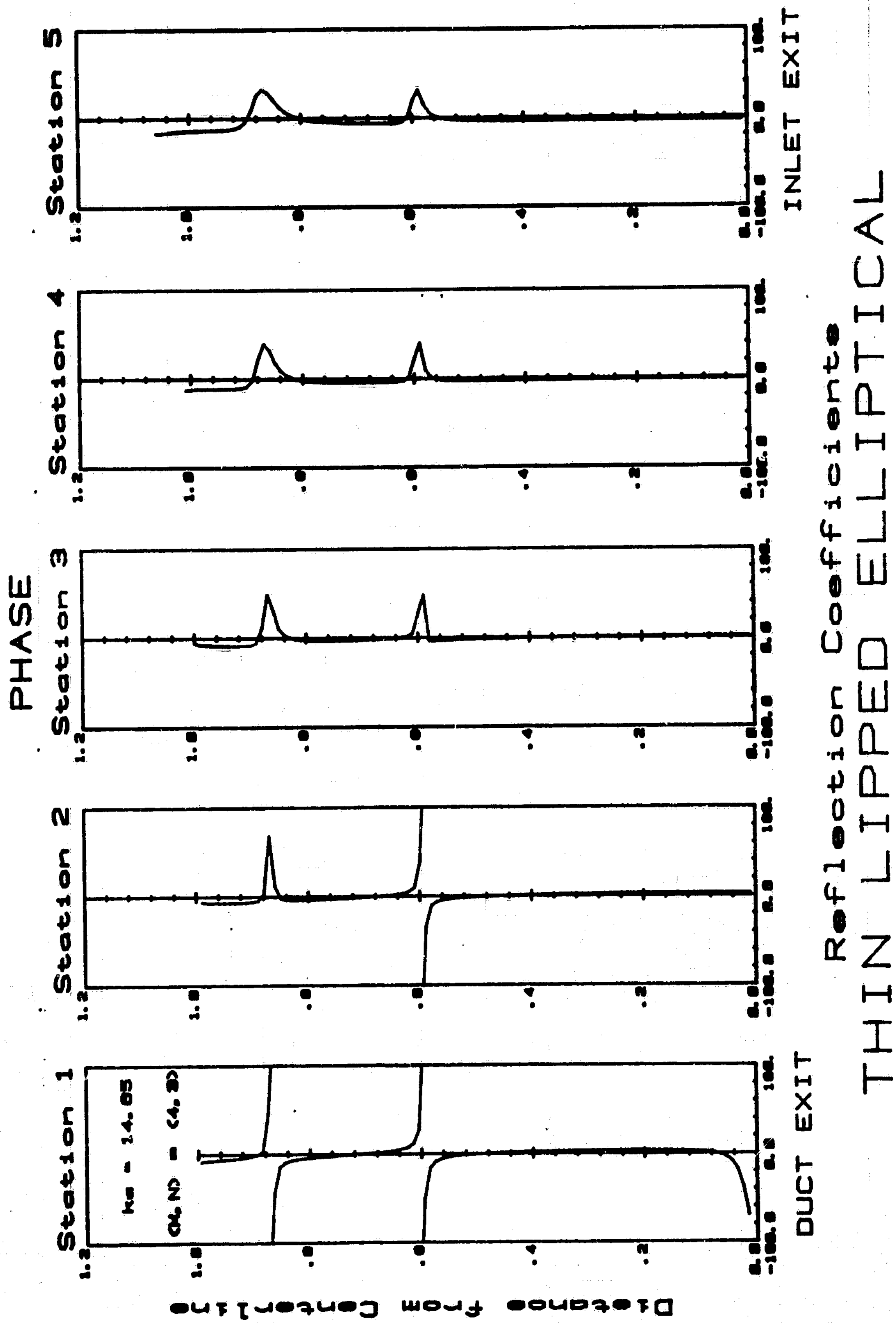

PHASE
Station 1
Station 2
Station 3
Station 4
Station 5
ks = 14.65
(M,N) = (4,3)
DUCT EXIT
INLET EXIT
Distance From Centerline
Reflection Coefficients
THIN LIPPED ELLIPTICAL

Fig. 26h

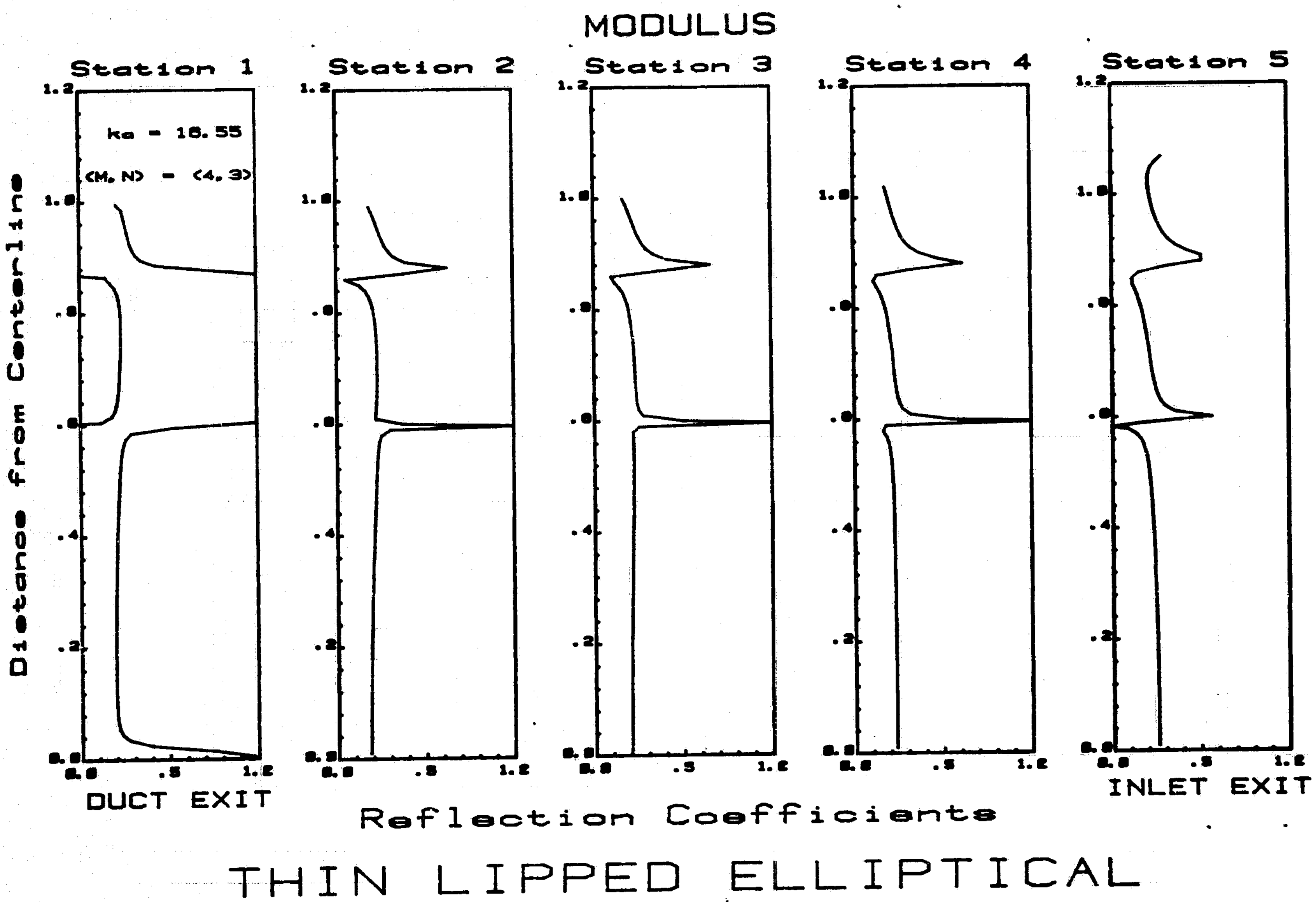

MODULUS
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 18.55
(M, N) = (4, 3)
Distance from Centerline
DUCT EXIT
INLET EXIT
Reflection Coefficients
THIN LIPPED ELLIPTICAL

Fig. 26i

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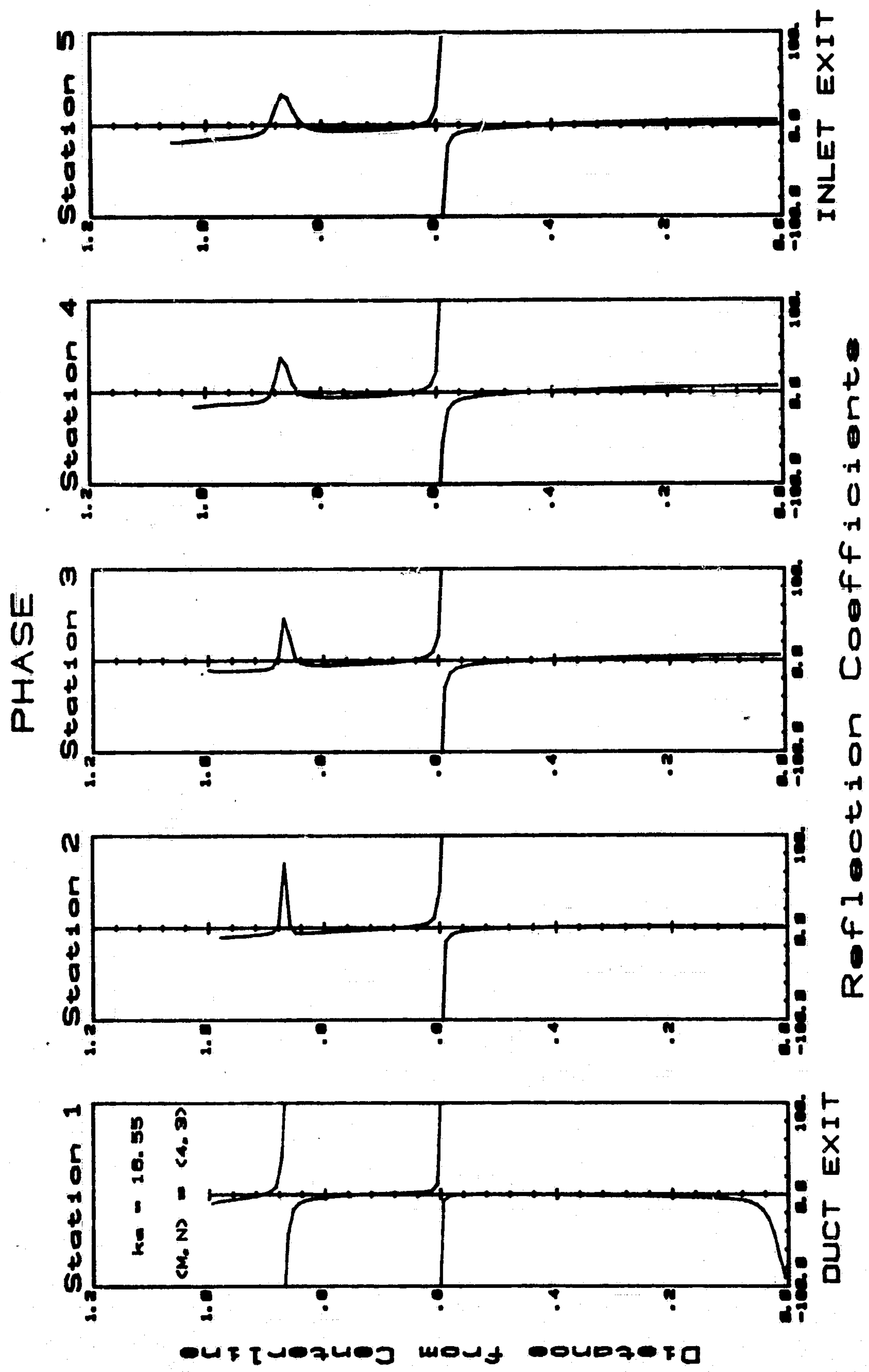


THIN LIPPED ELLIPTICAL

Fig. 26j

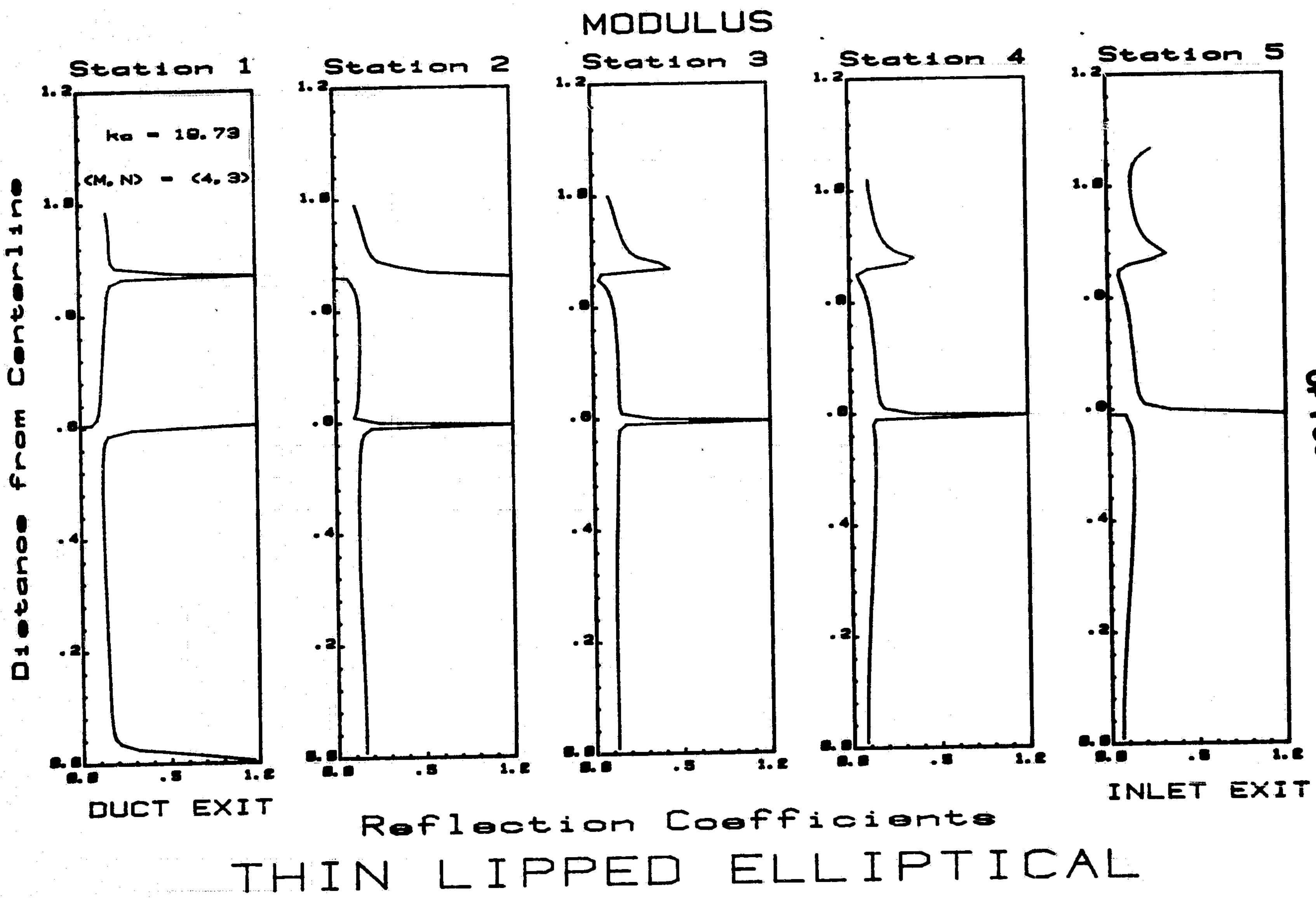
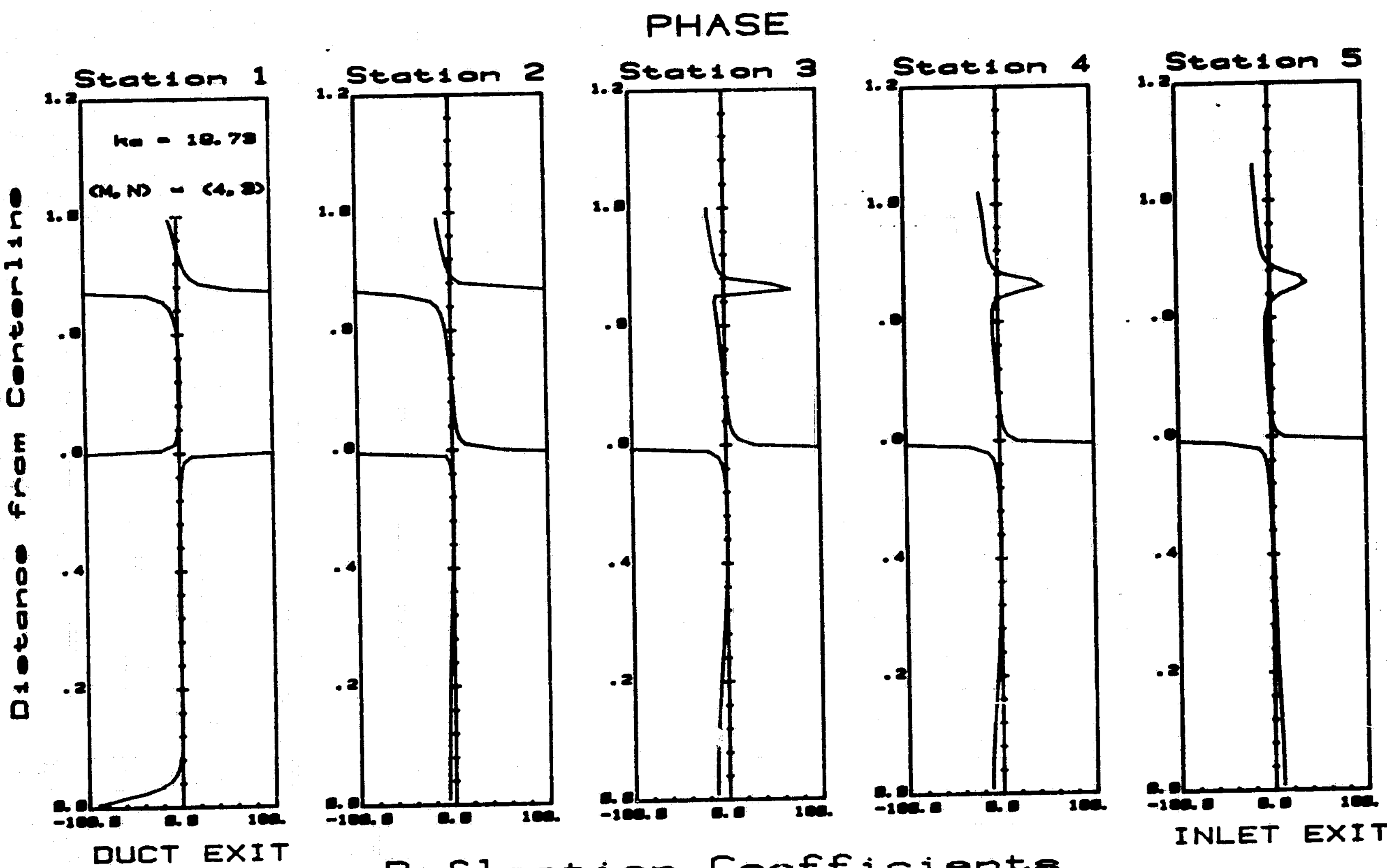
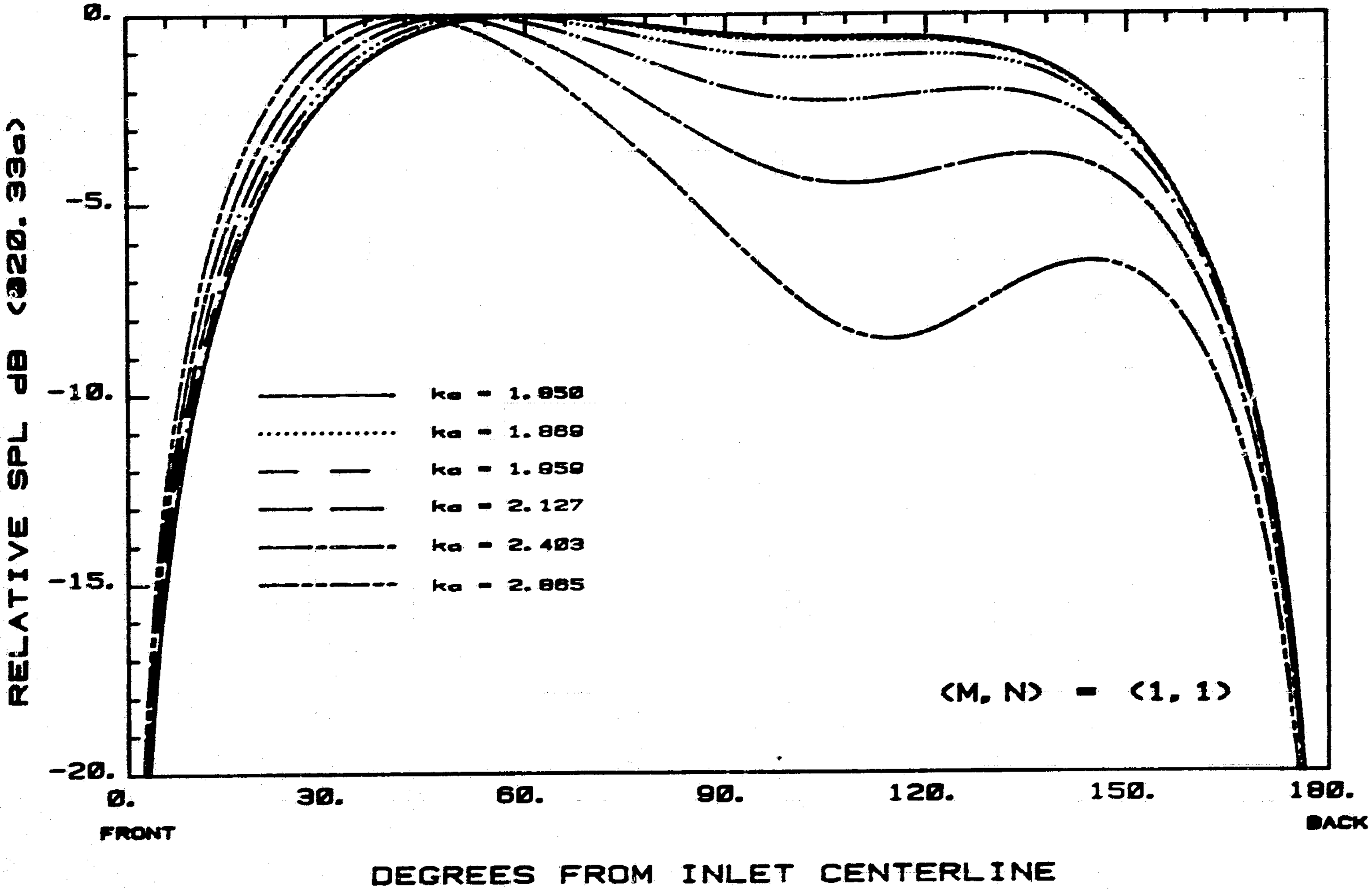

MODULUS
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 10.73
(M, N) = (4, 3)
Distance from Centerline
DUCT EXIT
INLET EXIT
Reflection Coefficients
THIN LIPPED ELLIPTICAL

Fig. 26k



THIN LIPPED ELLIPTICAL

Fig. 261



THIN LIPPED ELLIPTICAL INLET

Fig. 27a

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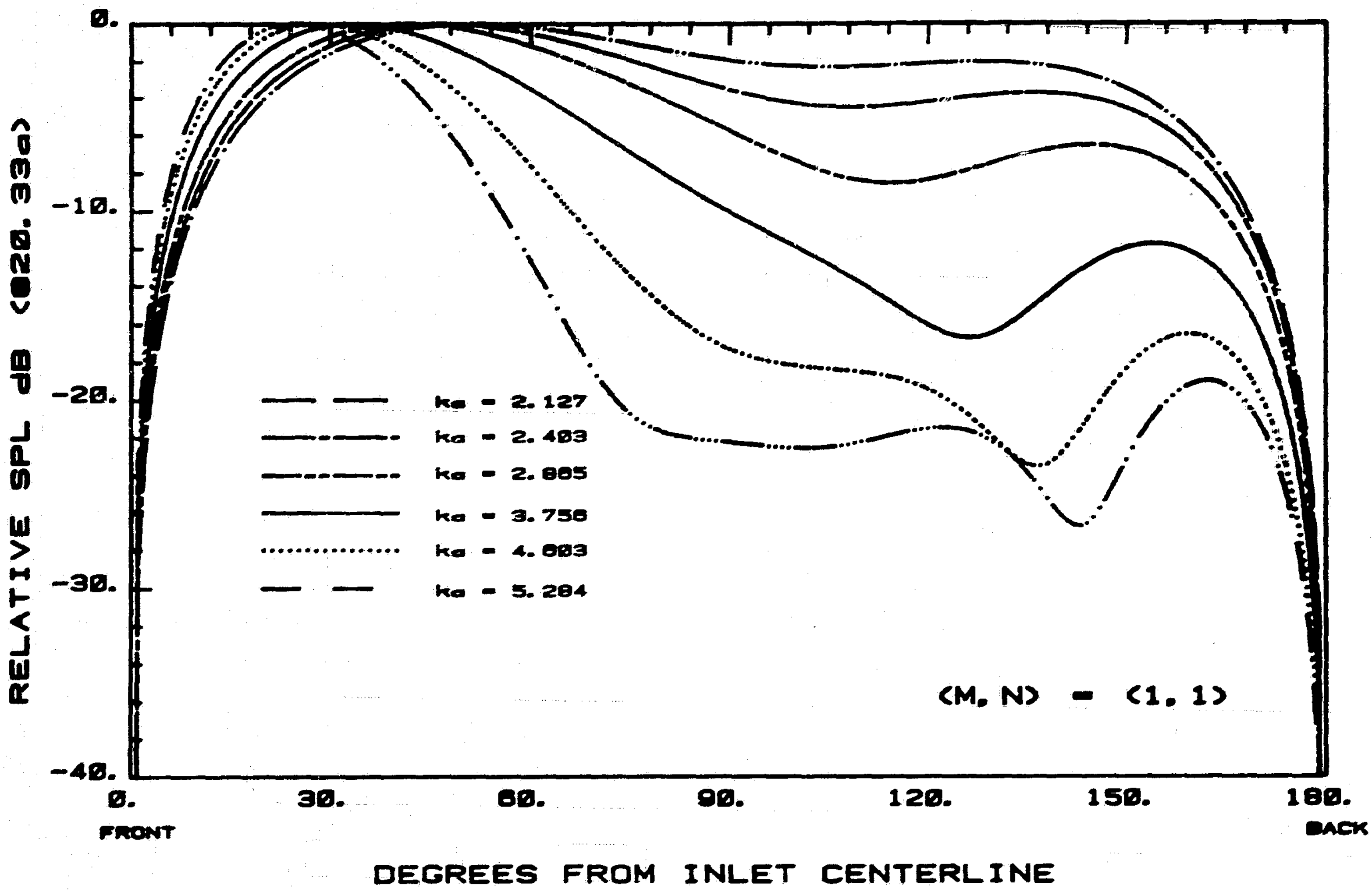
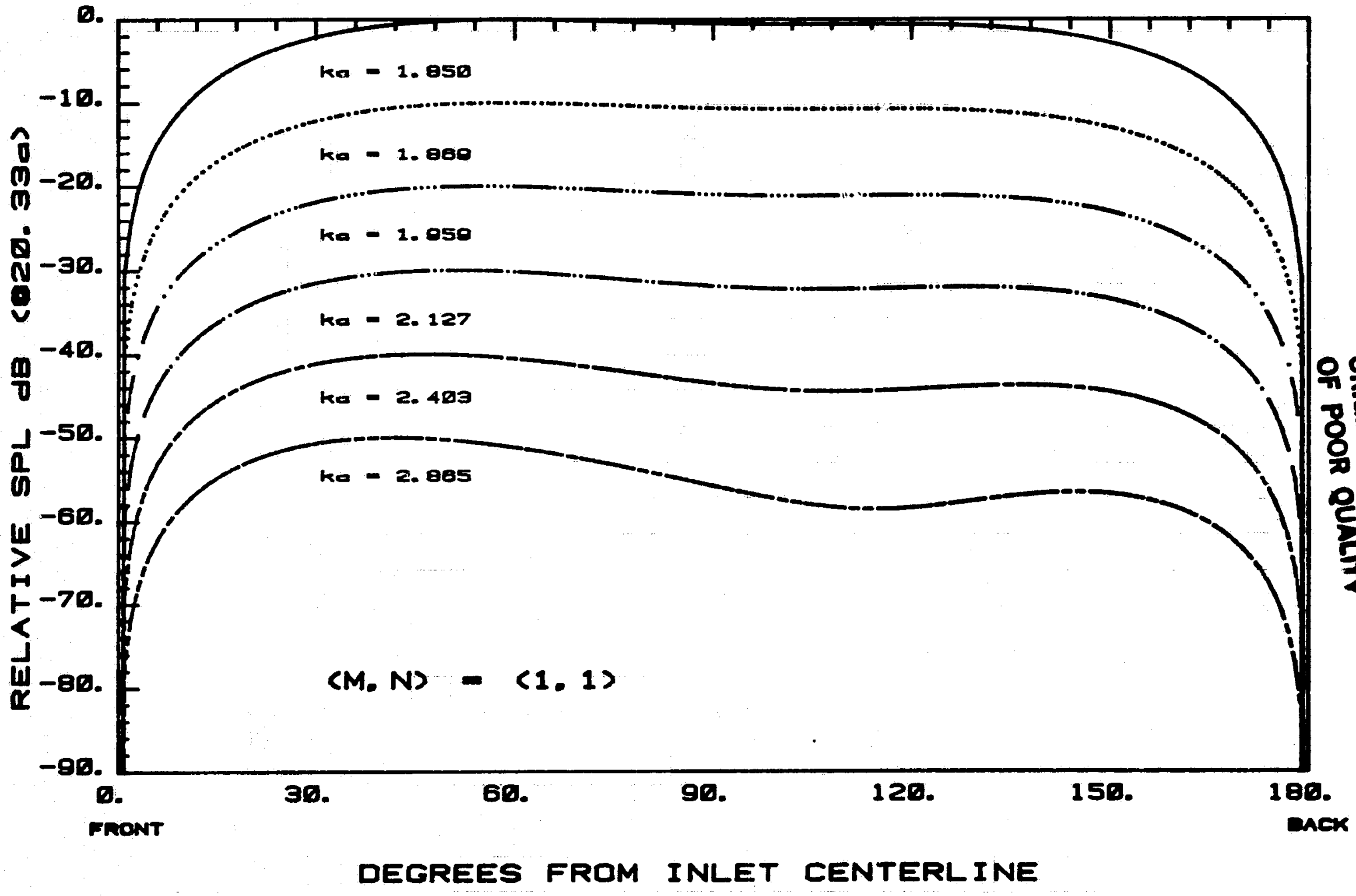


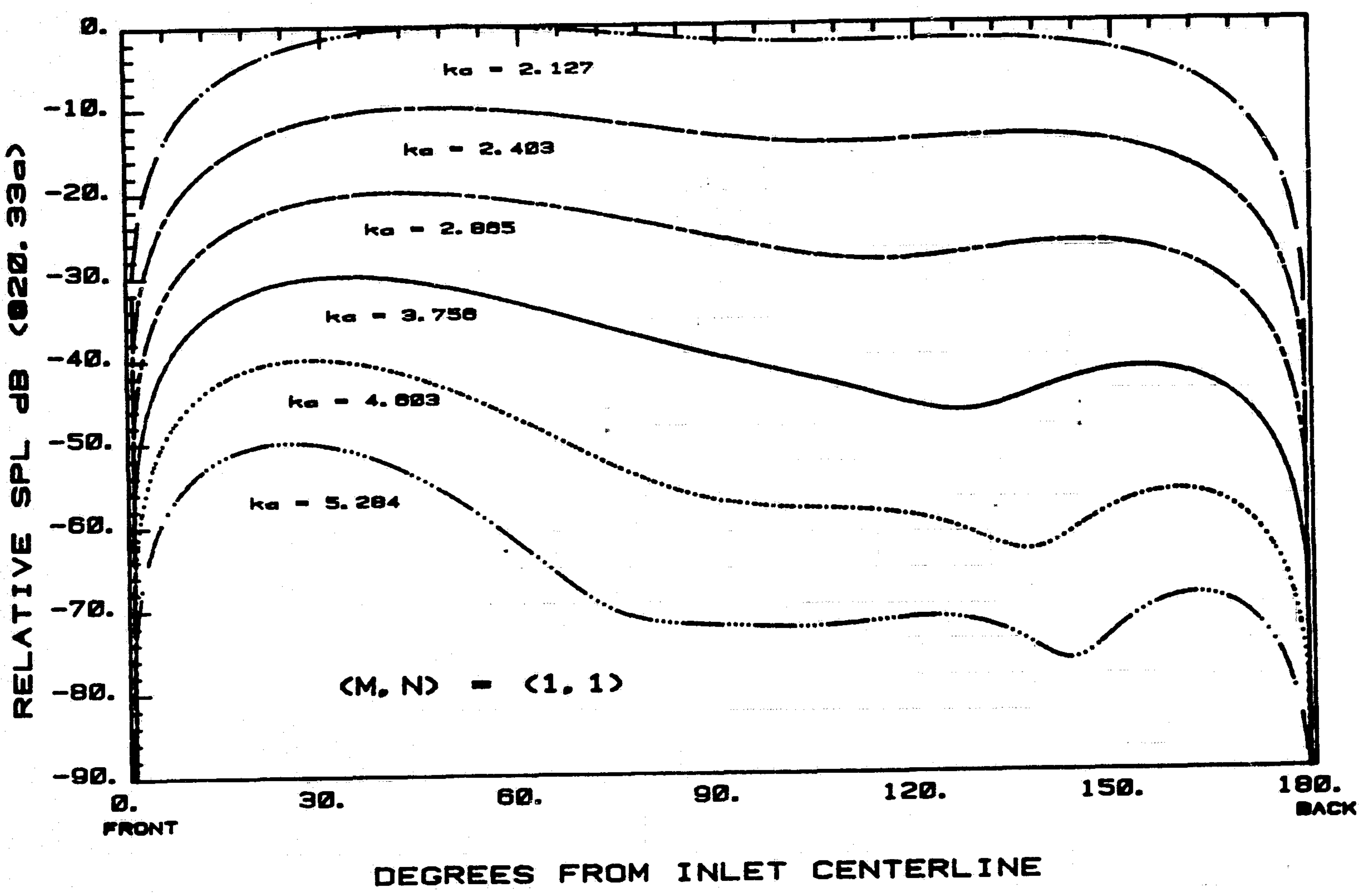
THIN LIPPED ELLIPTICAL INLET

Fig. 27b



THIN LIPPED ELLIPTICAL INLET

Fig. 27c



THIN LIPPED ELLIPTICAL INLET

Fig. 27d

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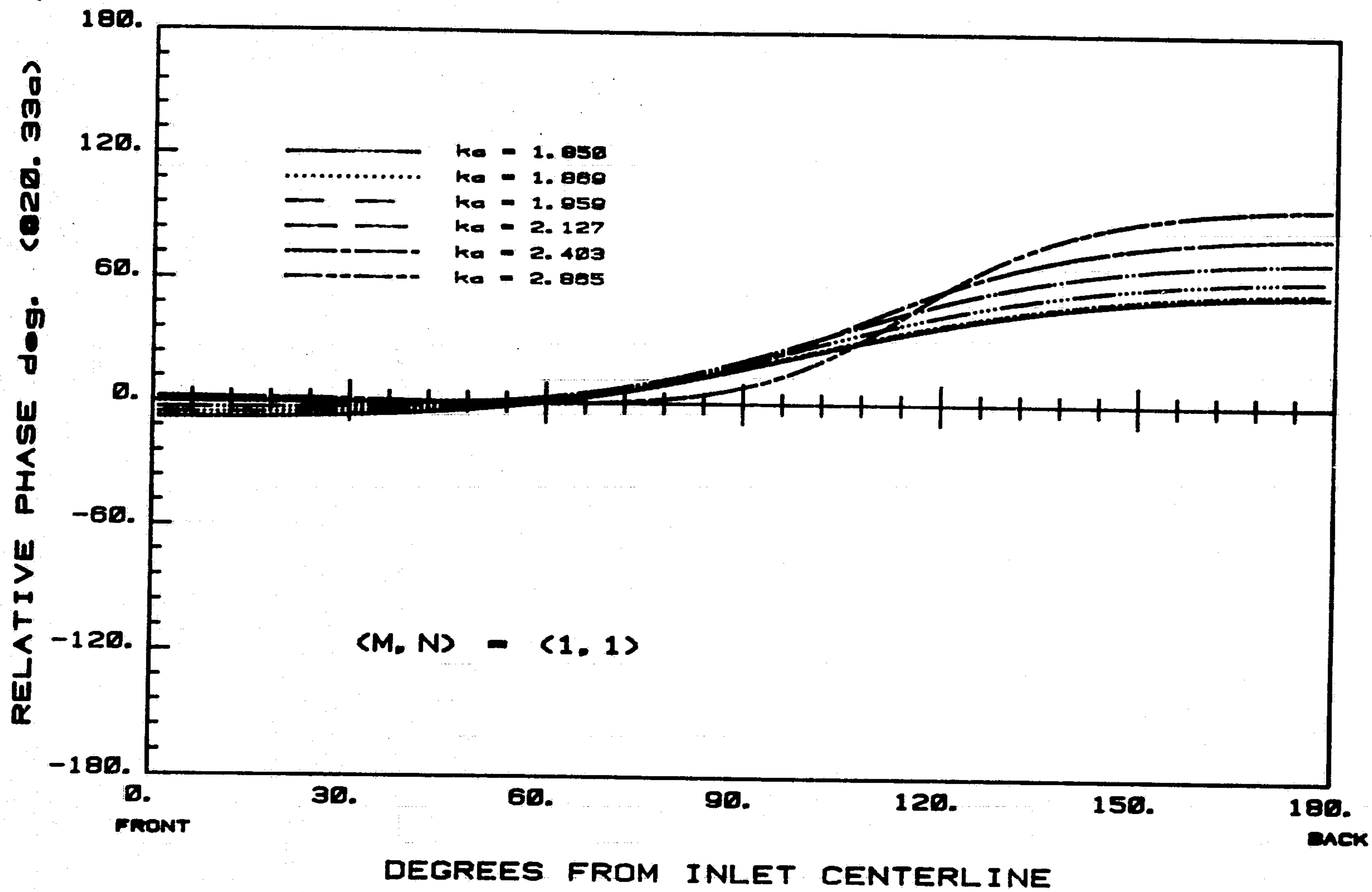
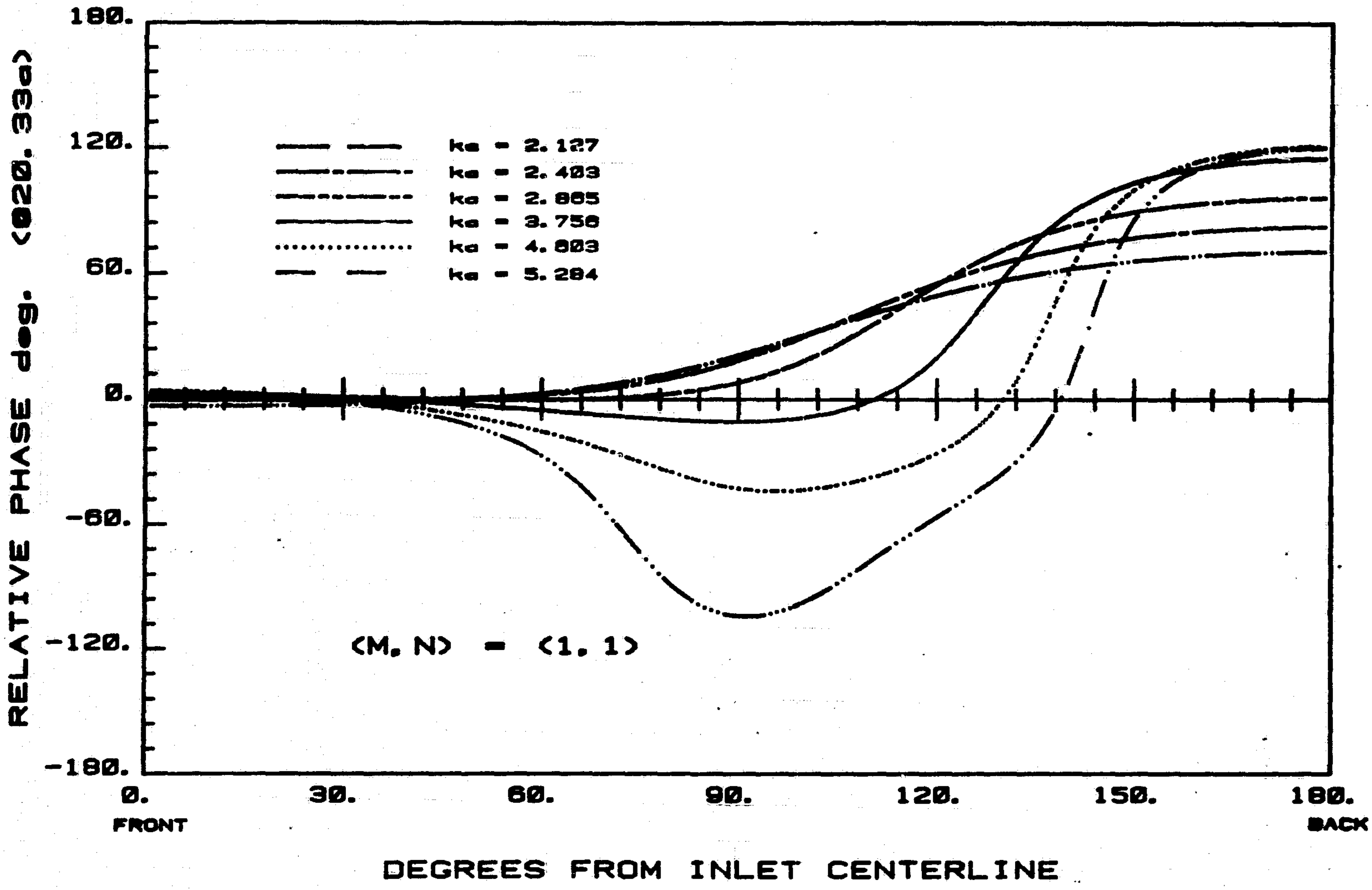


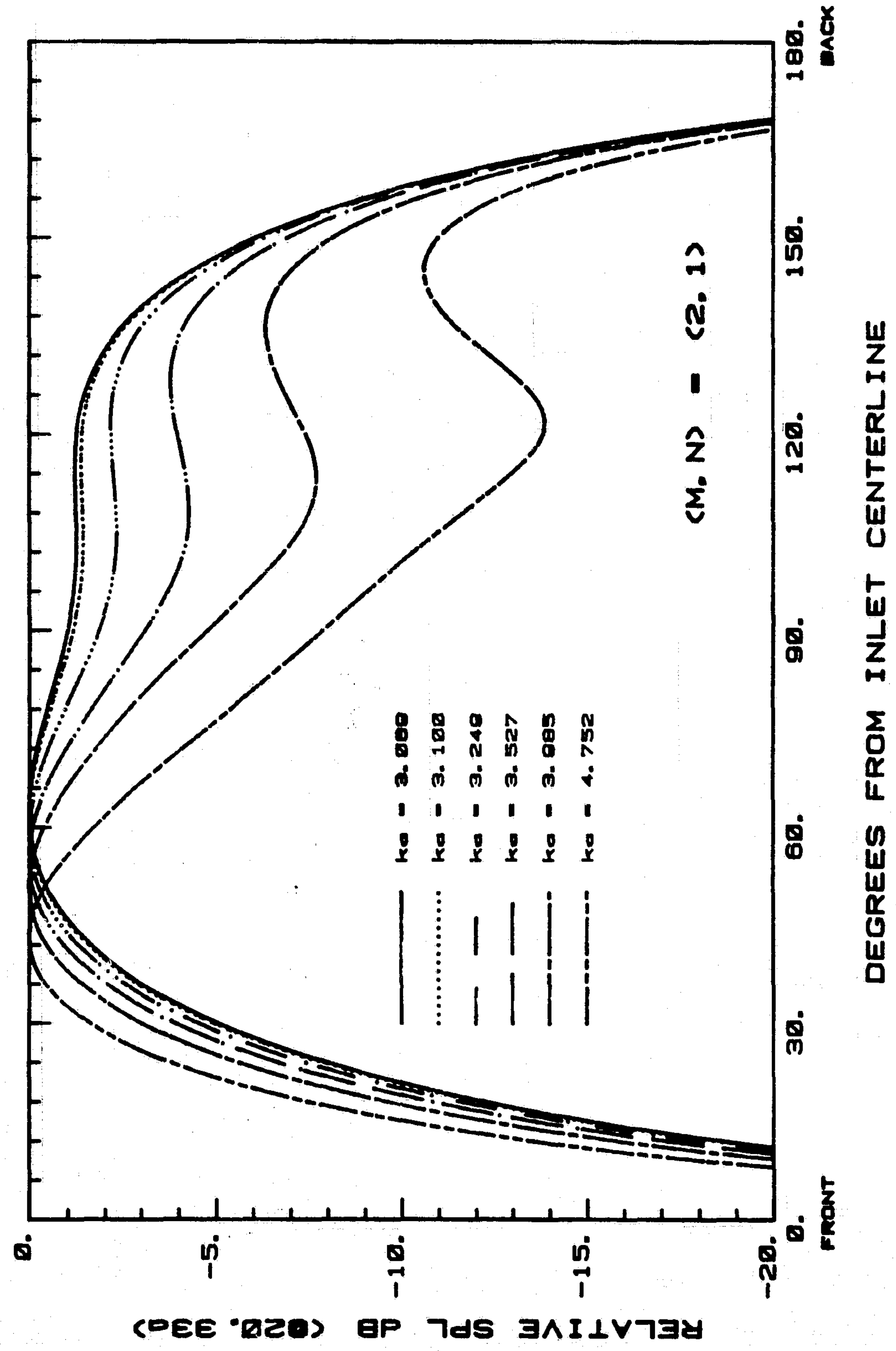
THIN LIPPED ELLIPTICAL INLET

Fig. 27e



THIN LIPPED ELLIPTICAL INLET

Fig. 27f



THIN LIPPED ELLIPTICAL INLET

Fig. 28a

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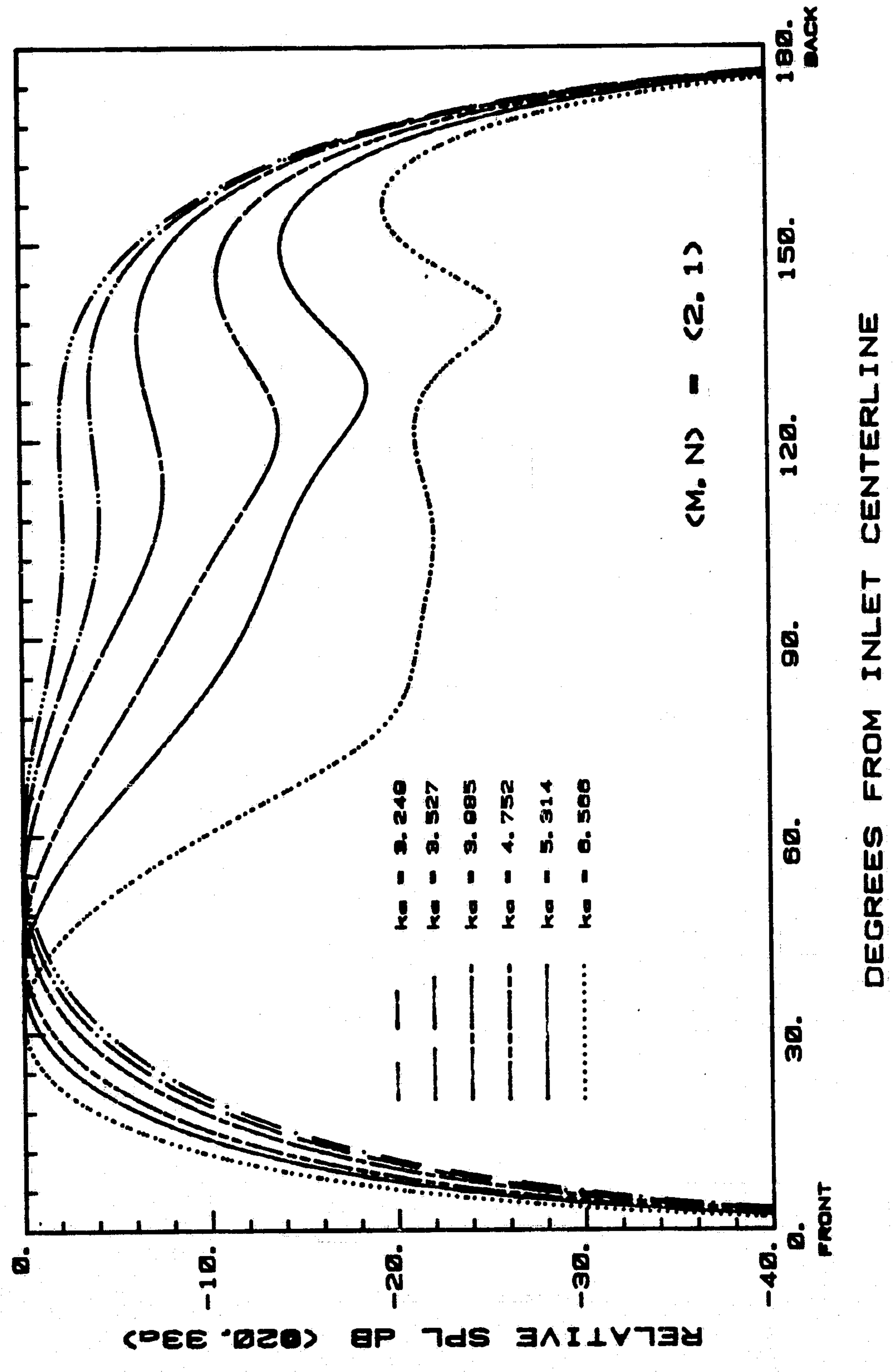
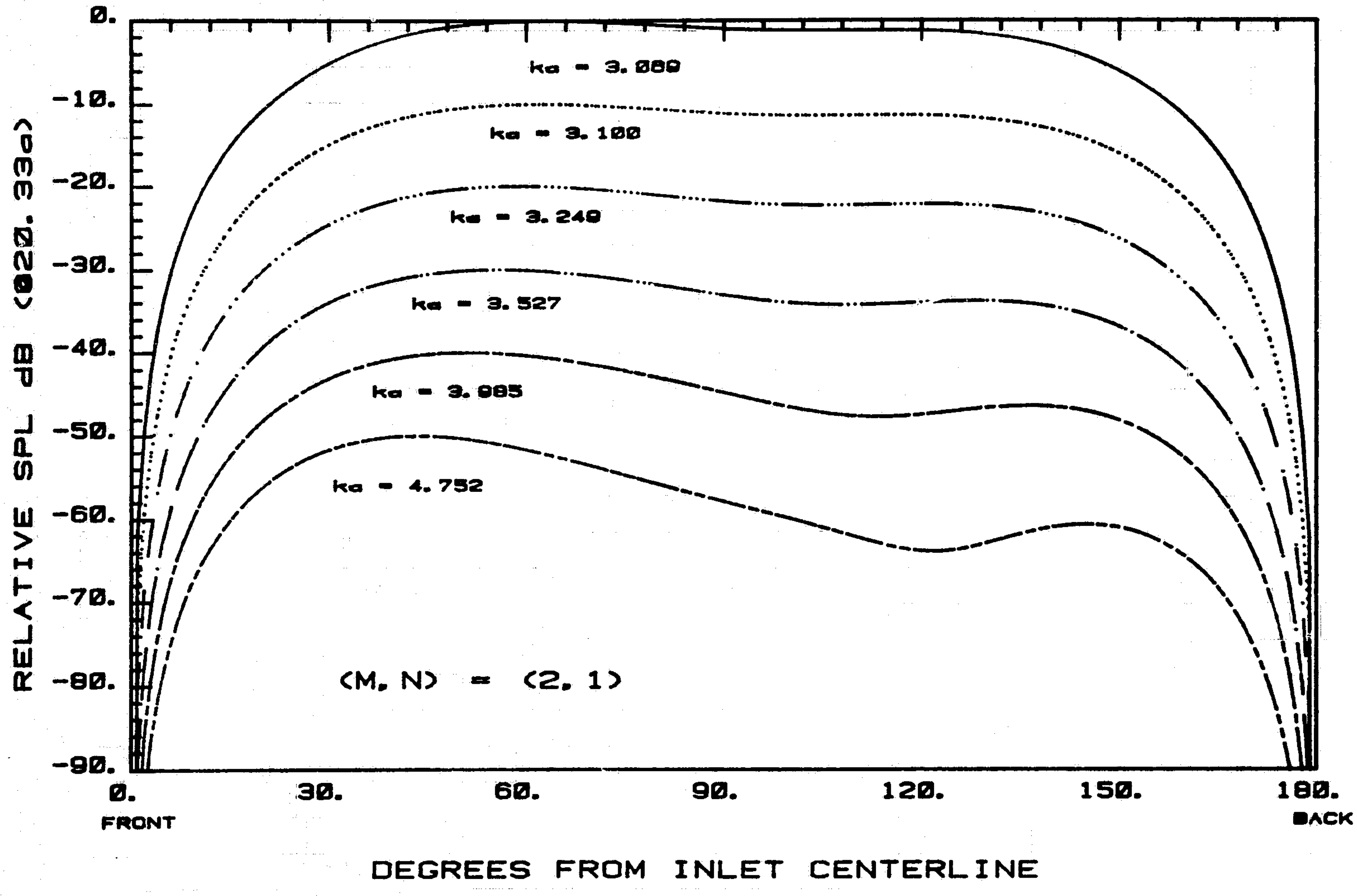


THIN LIPPED ELLIPTICAL INLET

Fig. 28b



THIN LIPPED ELLIPTICAL INLET

Fig. 28c

ORIGINAL PAGE IS
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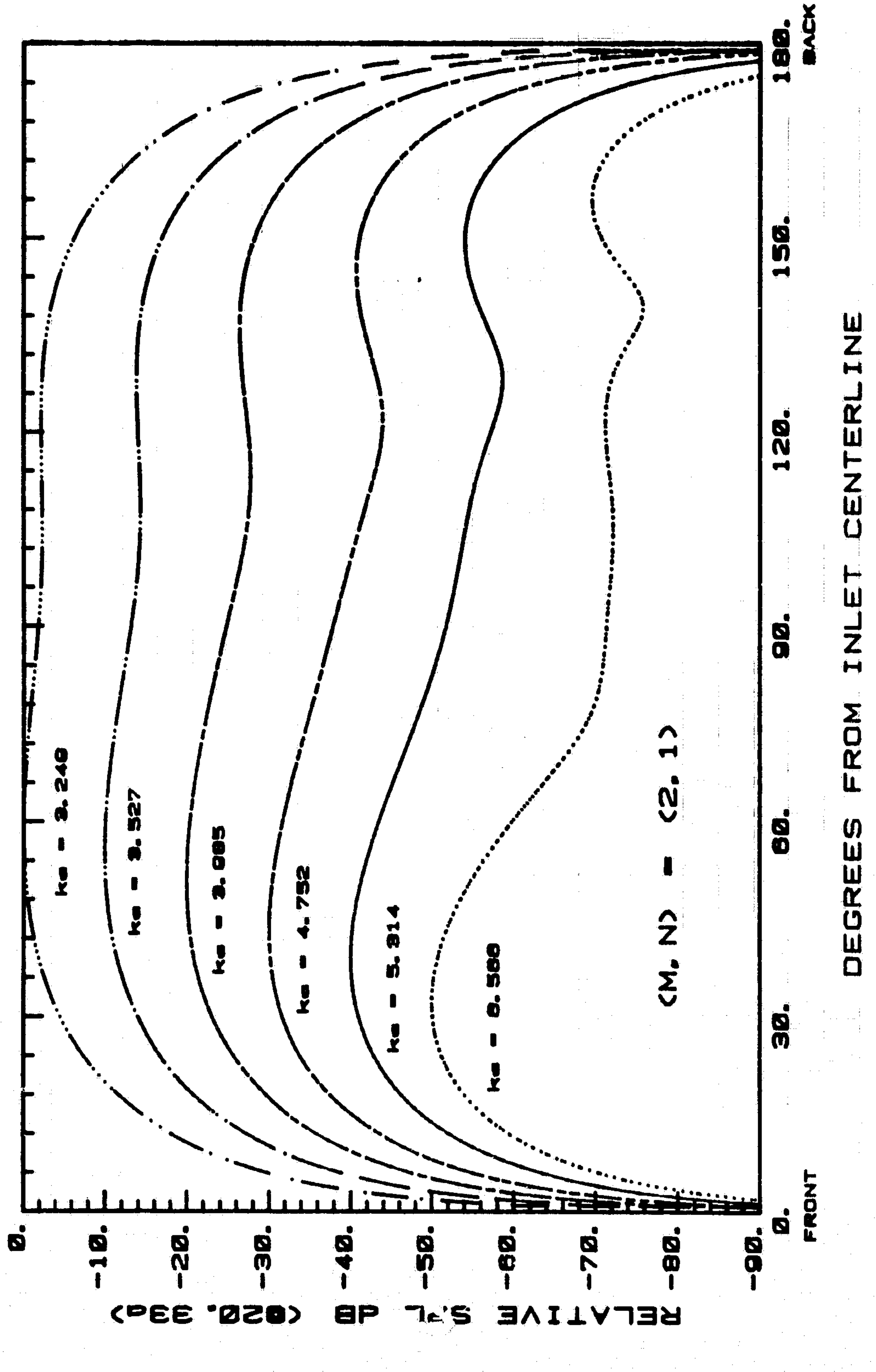
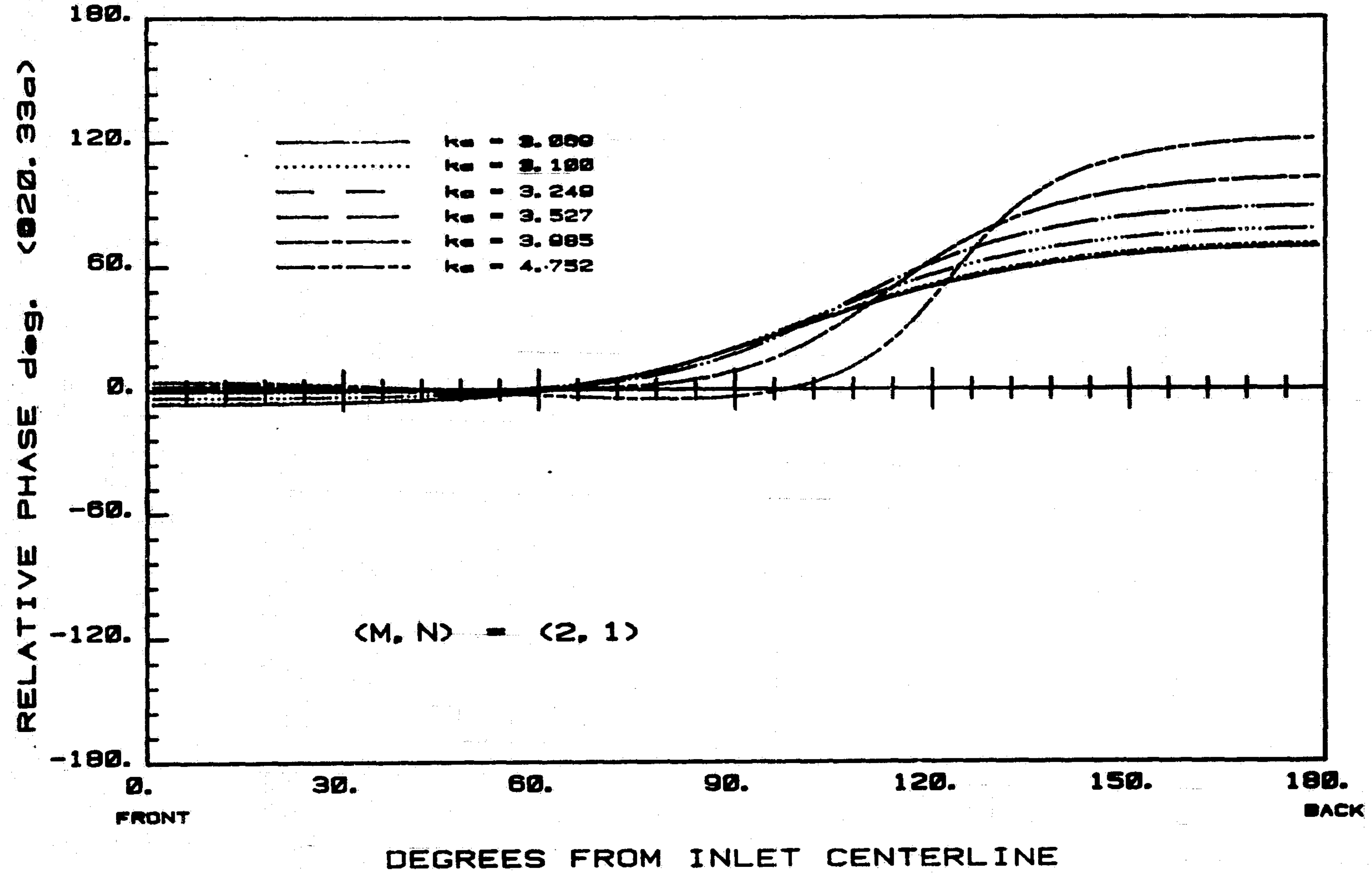


THIN LIPPED ELLIPTICAL INLET

Fig. 28d

ORIGINAL PAGE IS OF POOR QUALITY



THIN LIPPED ELLIPTICAL INLET

Fig. 28e

ORIGINAL PAGE IS
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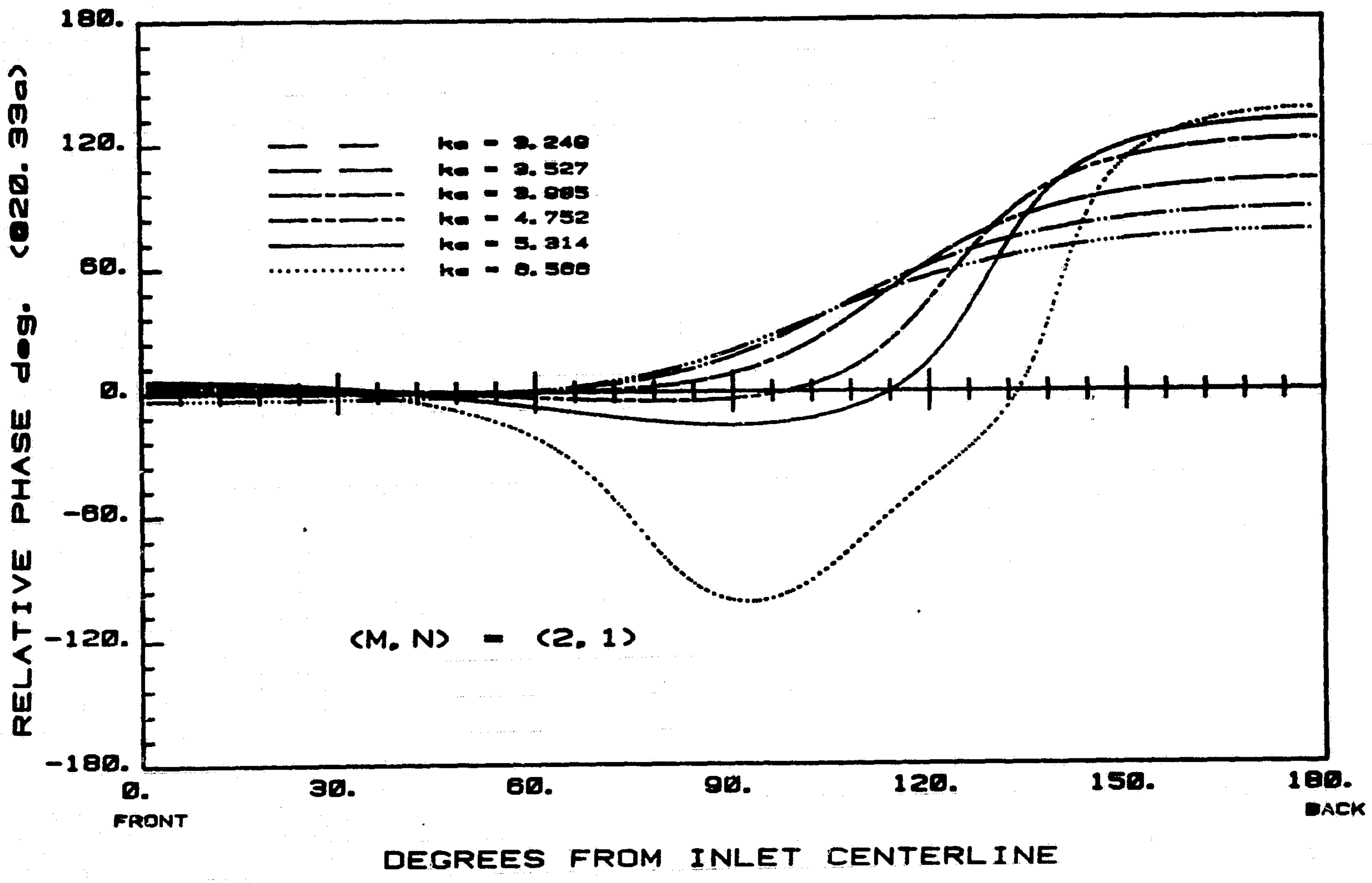
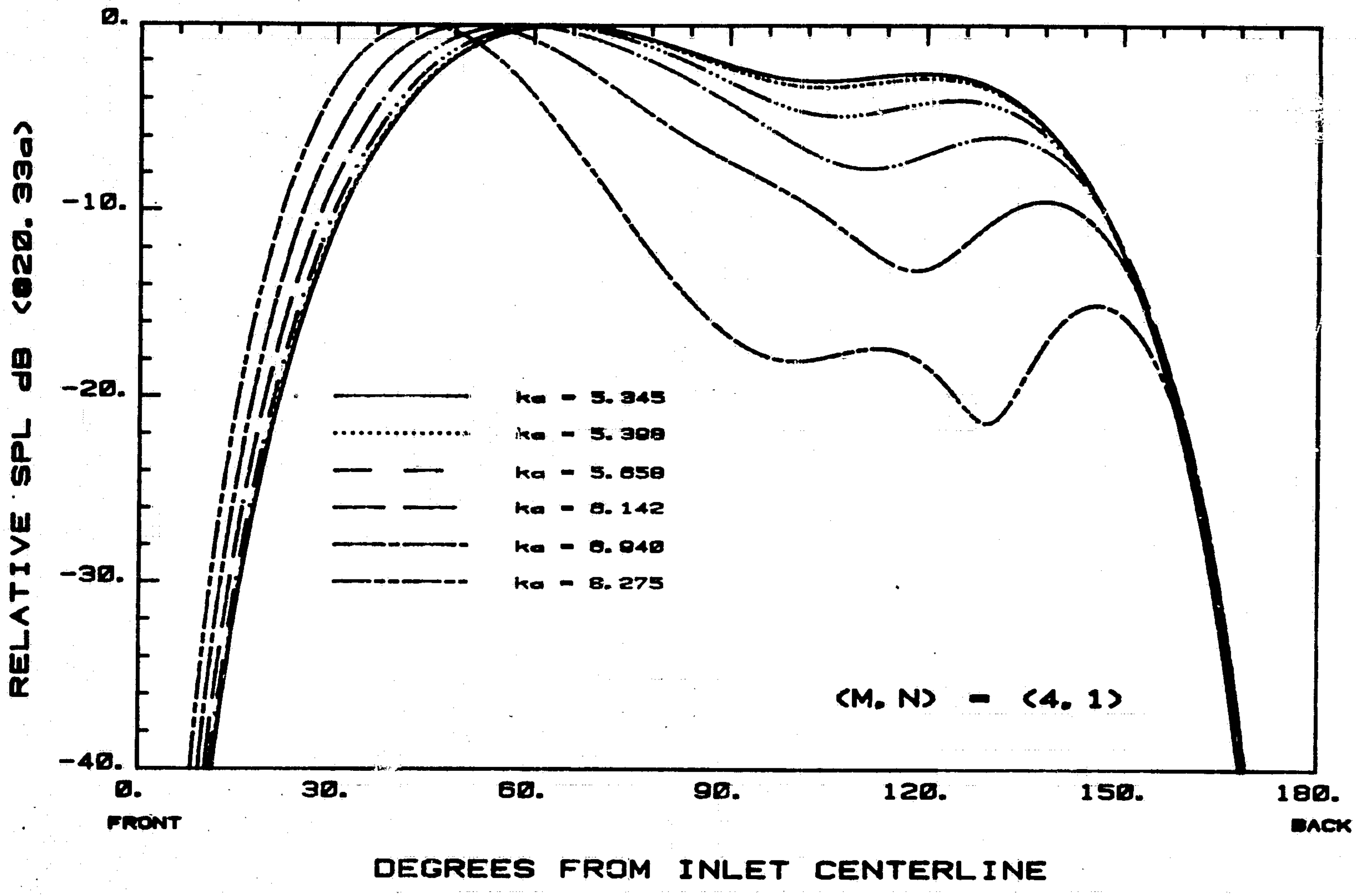


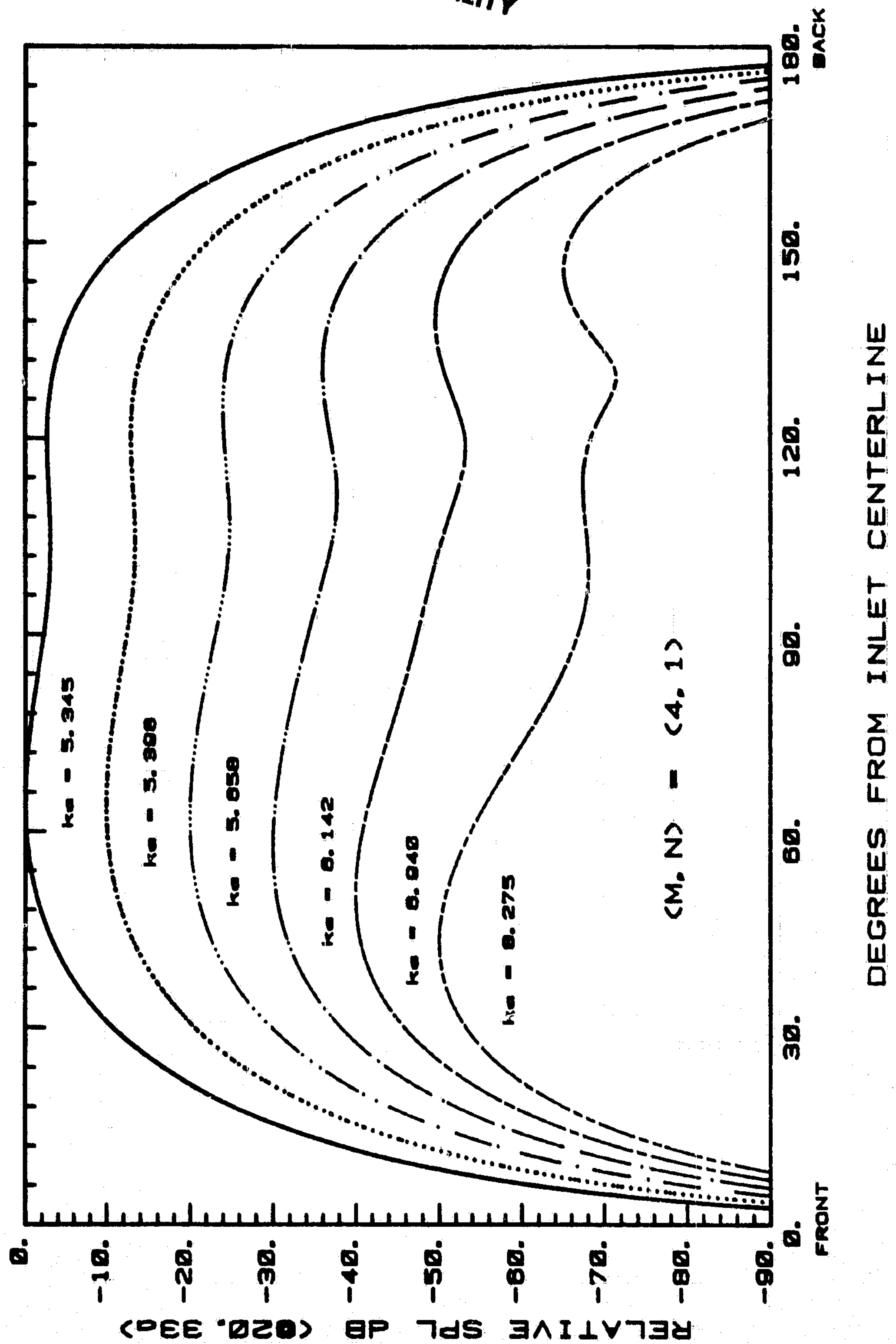
THIN LIPPED ELLIPTICAL INLET

Fig. 28f



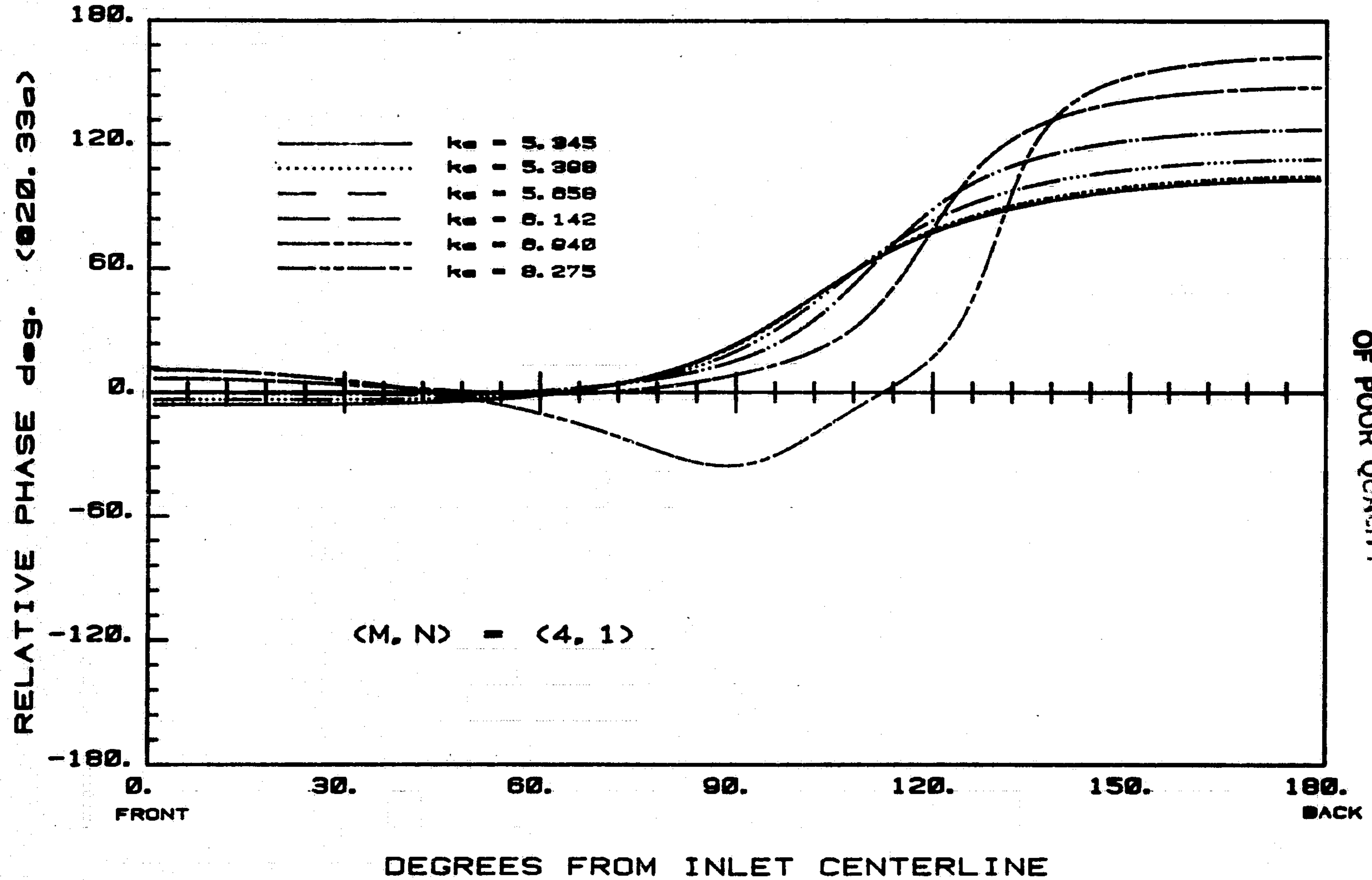
THIN LIPPED ELLIPTICAL INLET

Fig. 29a



THIN LIPPED ELLIPTICAL INLET

Fig. 29b



THIN LIPPED ELLIPTICAL INLET

Fig. 29c

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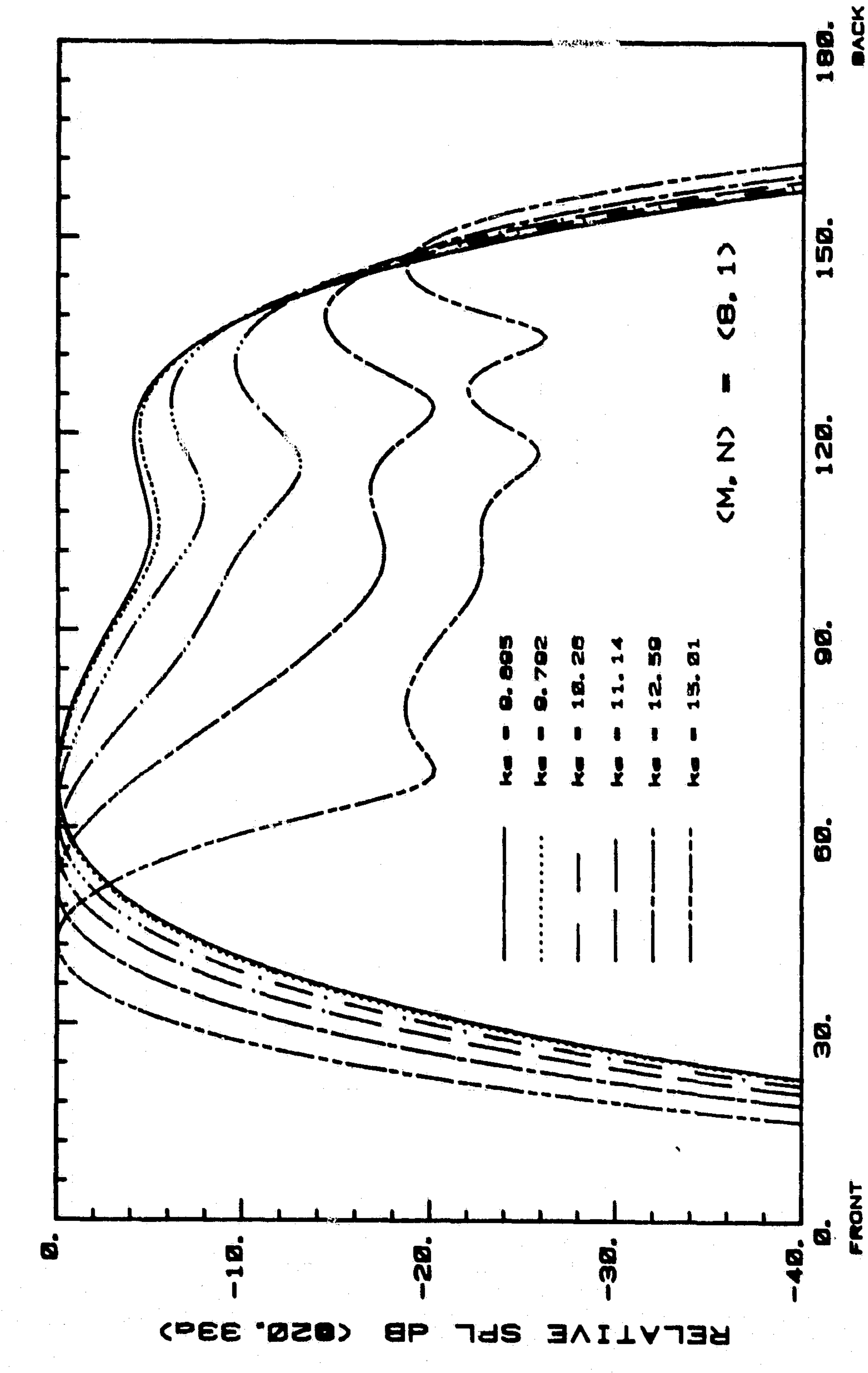
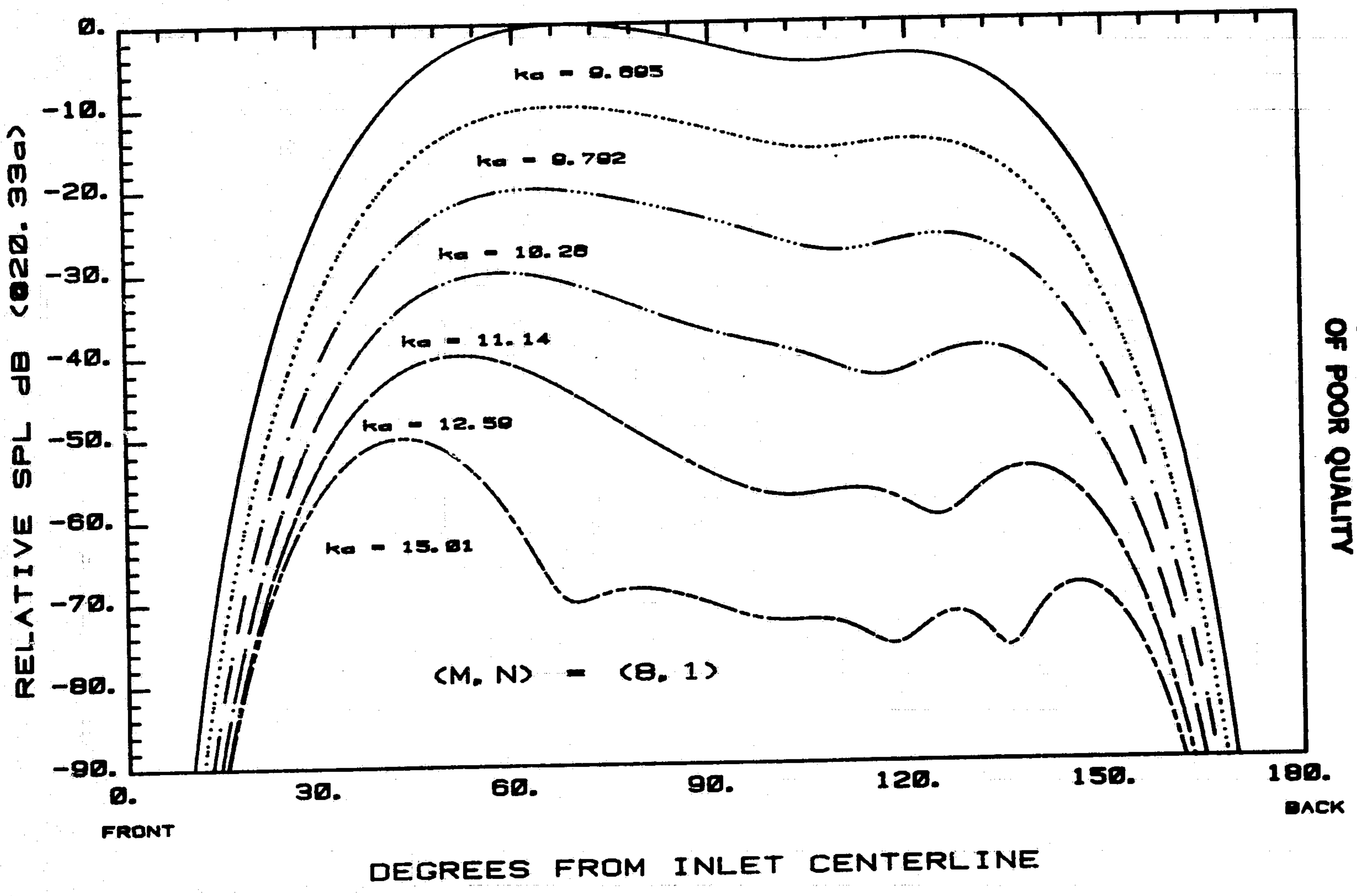


THIN LIPPED ELLIPTICAL INLET

Fig. 30a



THIN LIPPED ELLIPTICAL INLET

Fig. 30b

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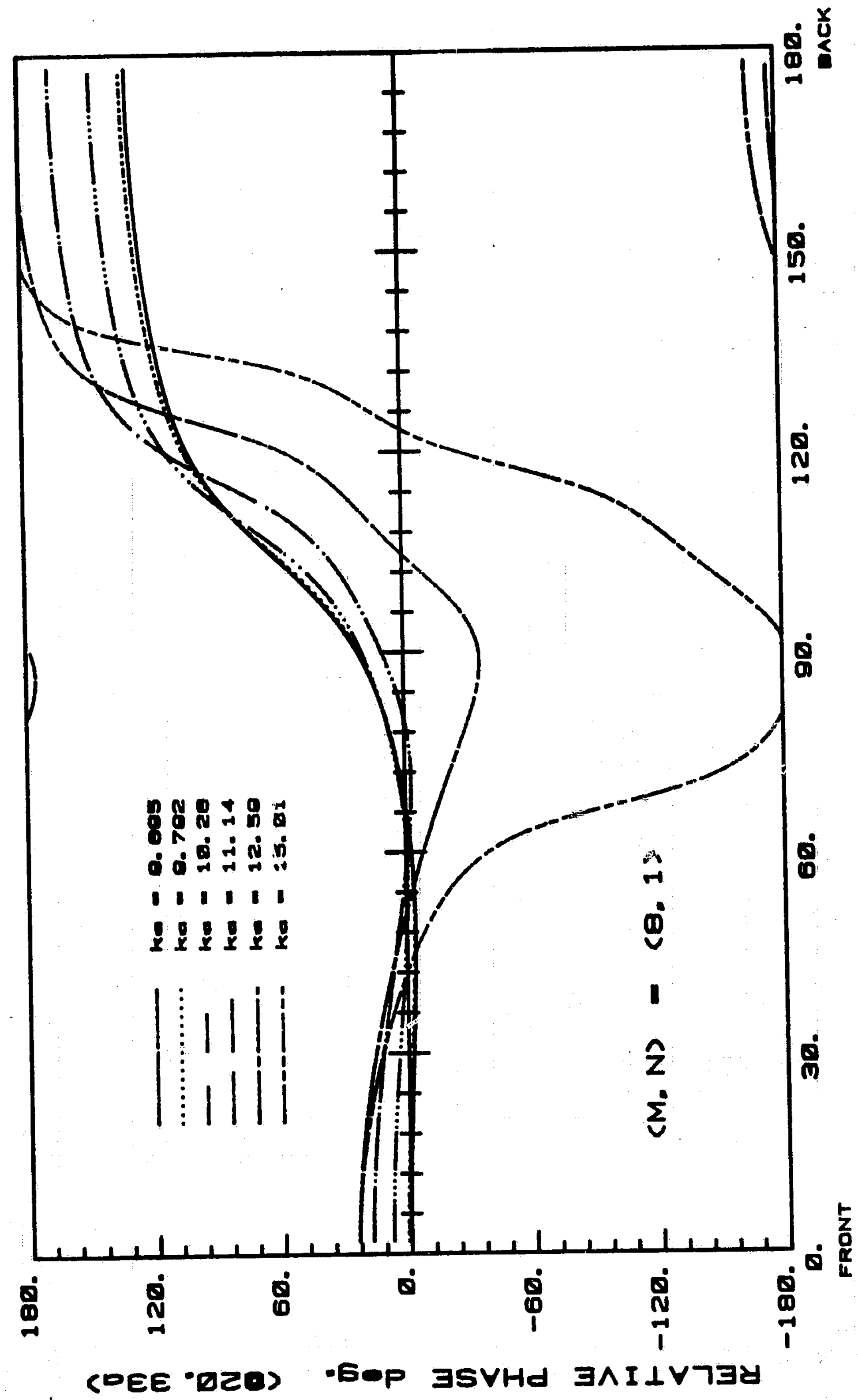
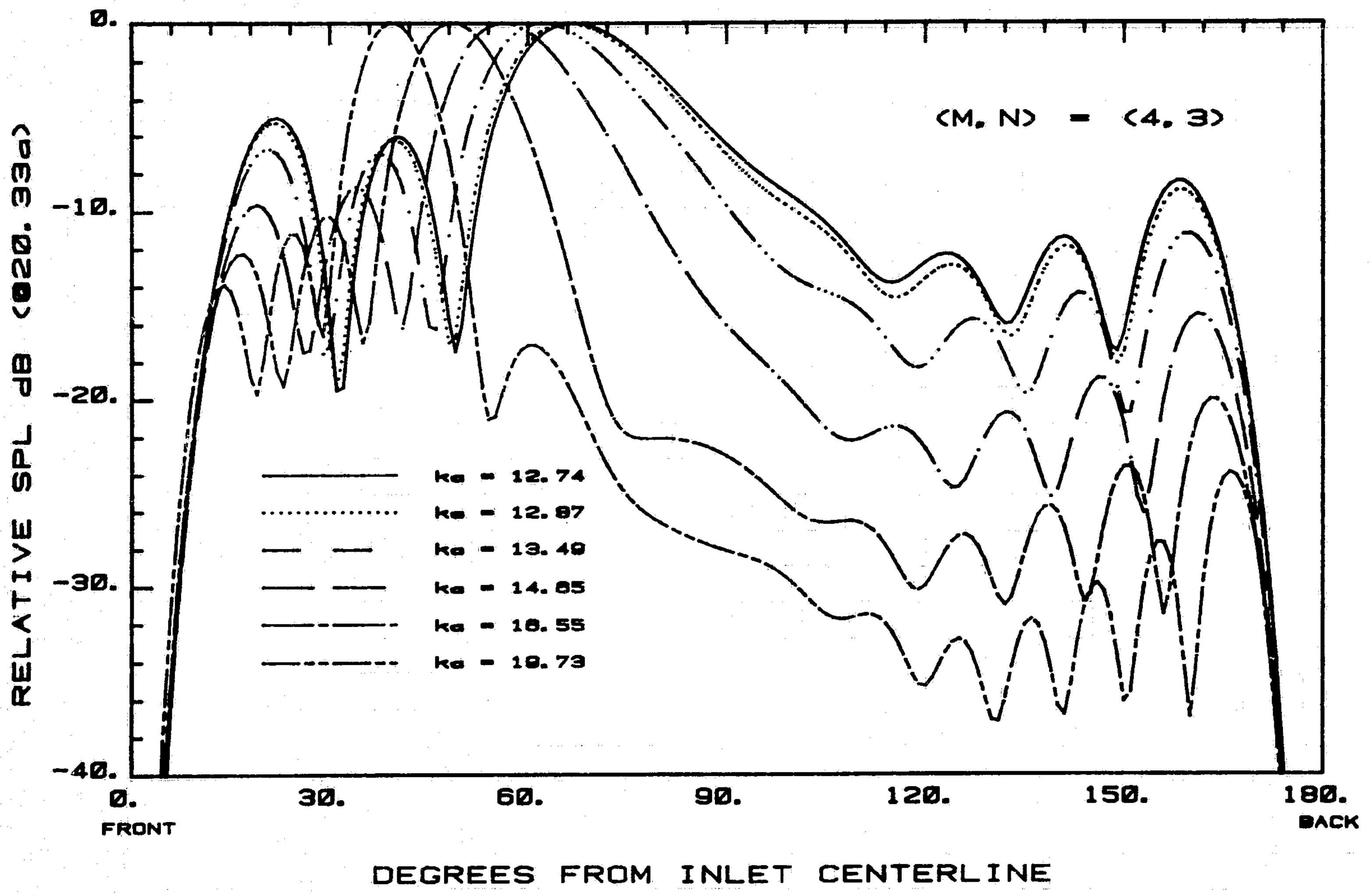


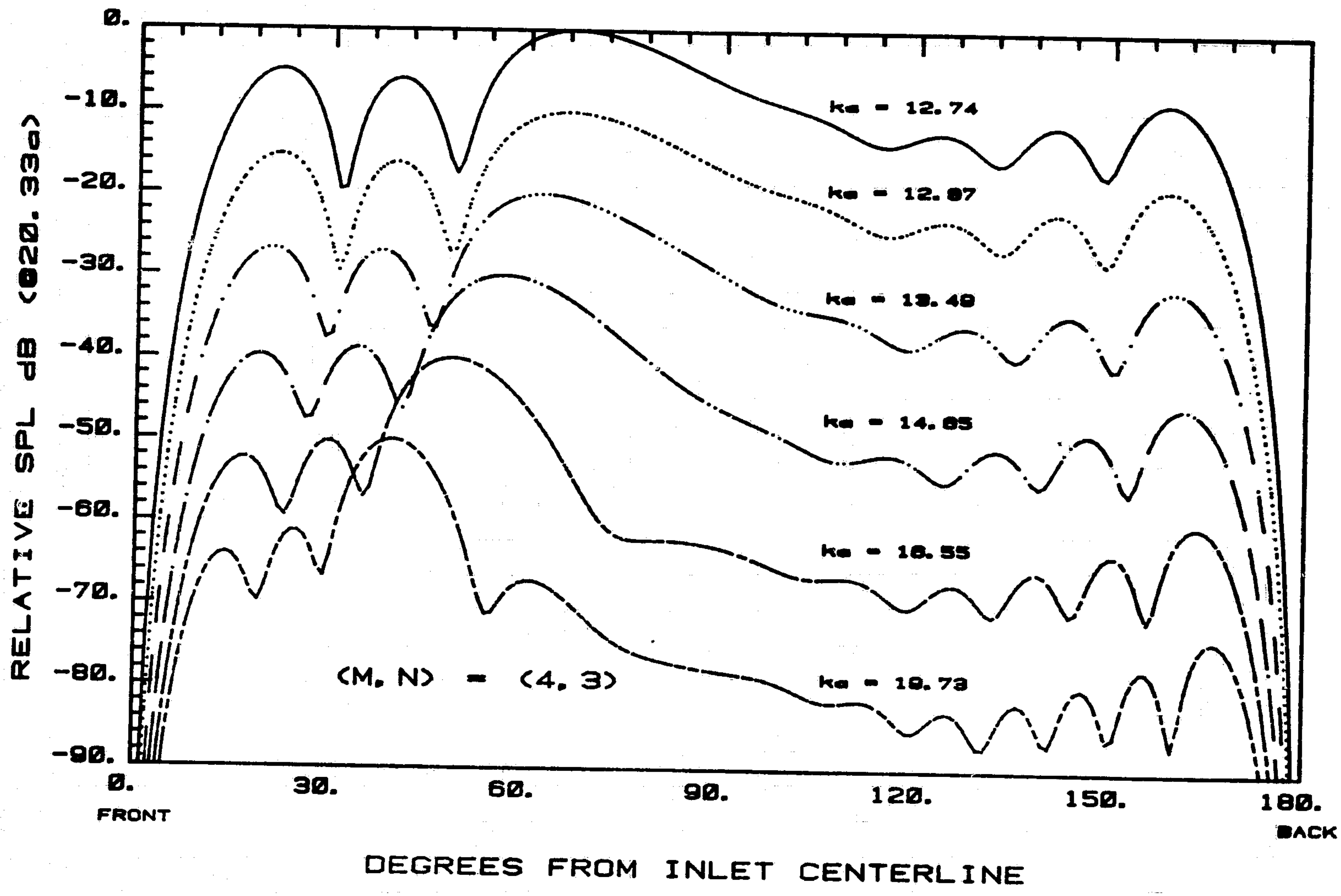
THIN LIPPED ELLIPTICAL INLET

Fig. 30c



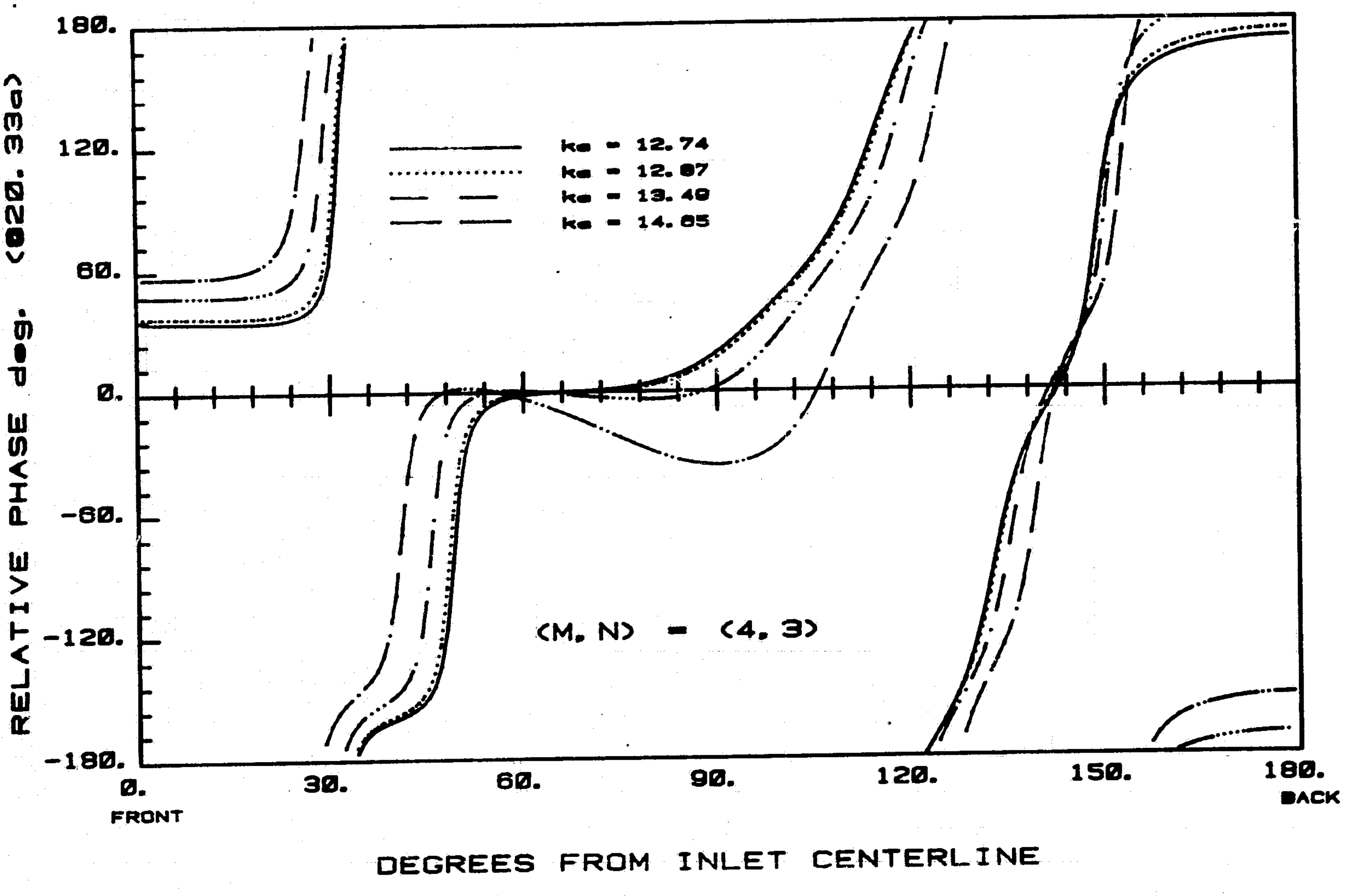
THIN LIPPED ELLIPTICAL INLET

Fig. 31a



THIN LIPPED ELLIPTICAL INLET

Fig. 31b



THIN LIPPED ELLIPTICAL INLET

Fig. 31c

ORIGINAL PAGE IS
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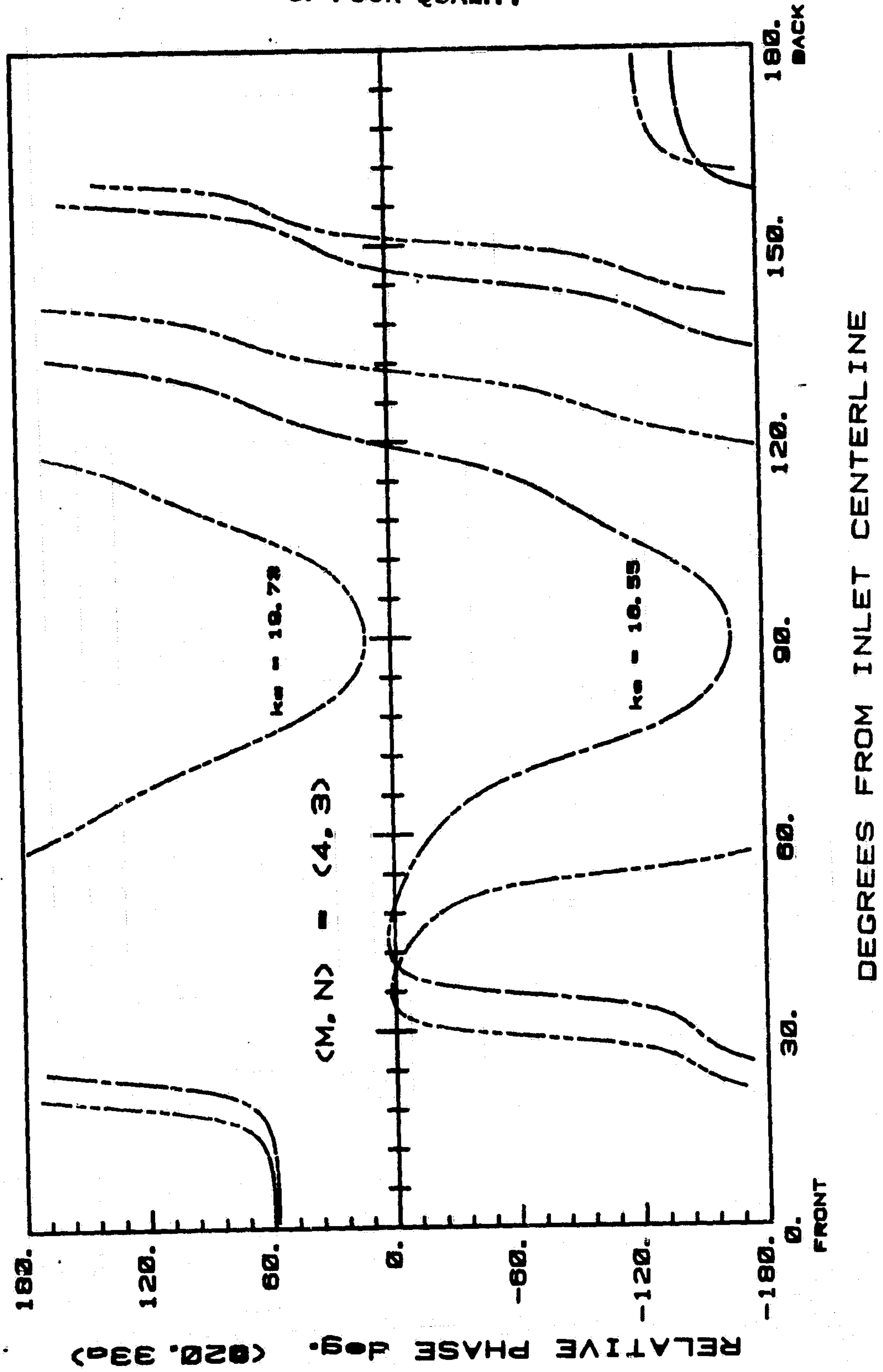

THIN LIPPED ELLIPTICAL INLET

Fig. 31d

ORIGINAL PAGE IS
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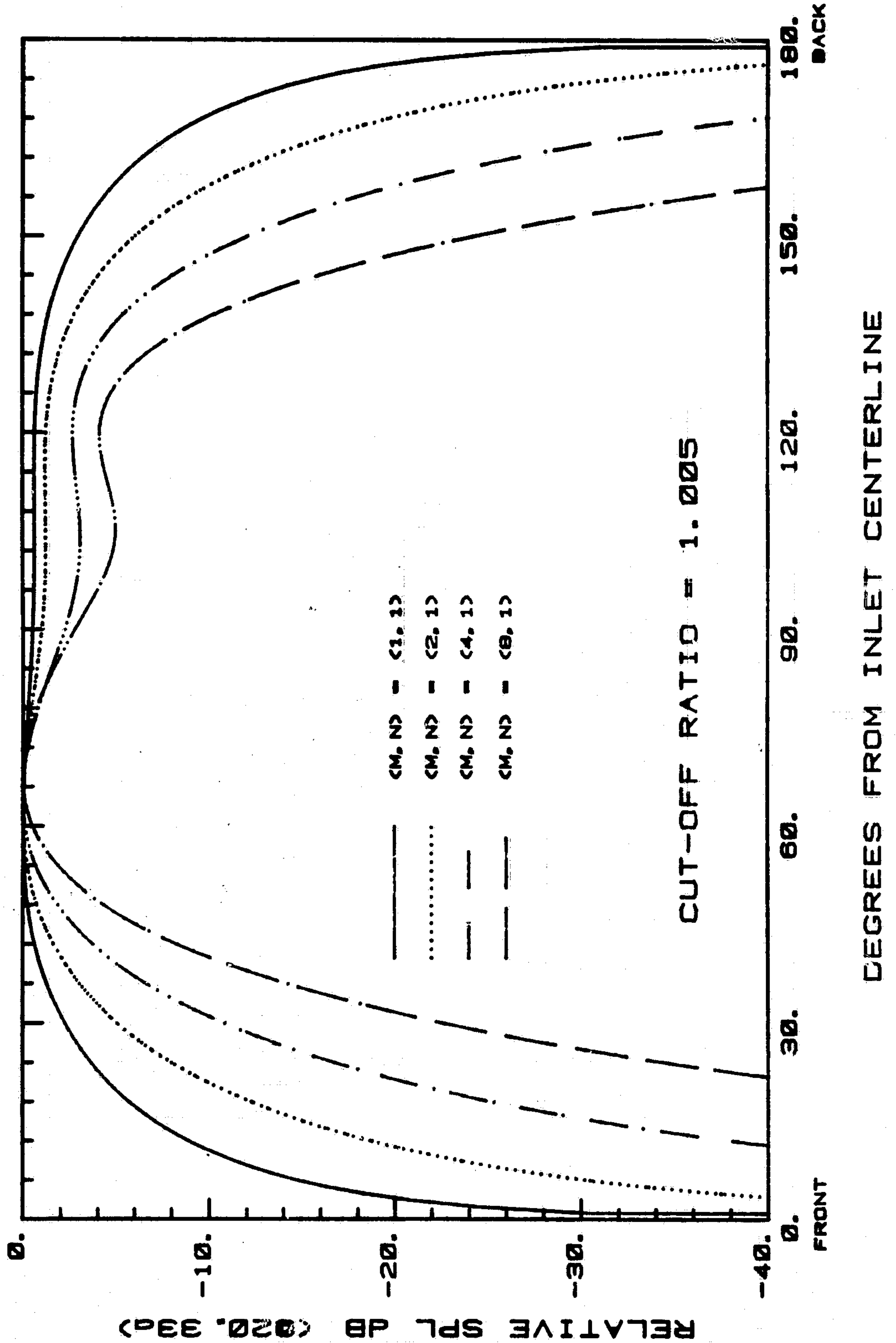

THIN LIPPED ELLIPTICAL INLET

Fig. 32a

ORIGINAL PAGE IS
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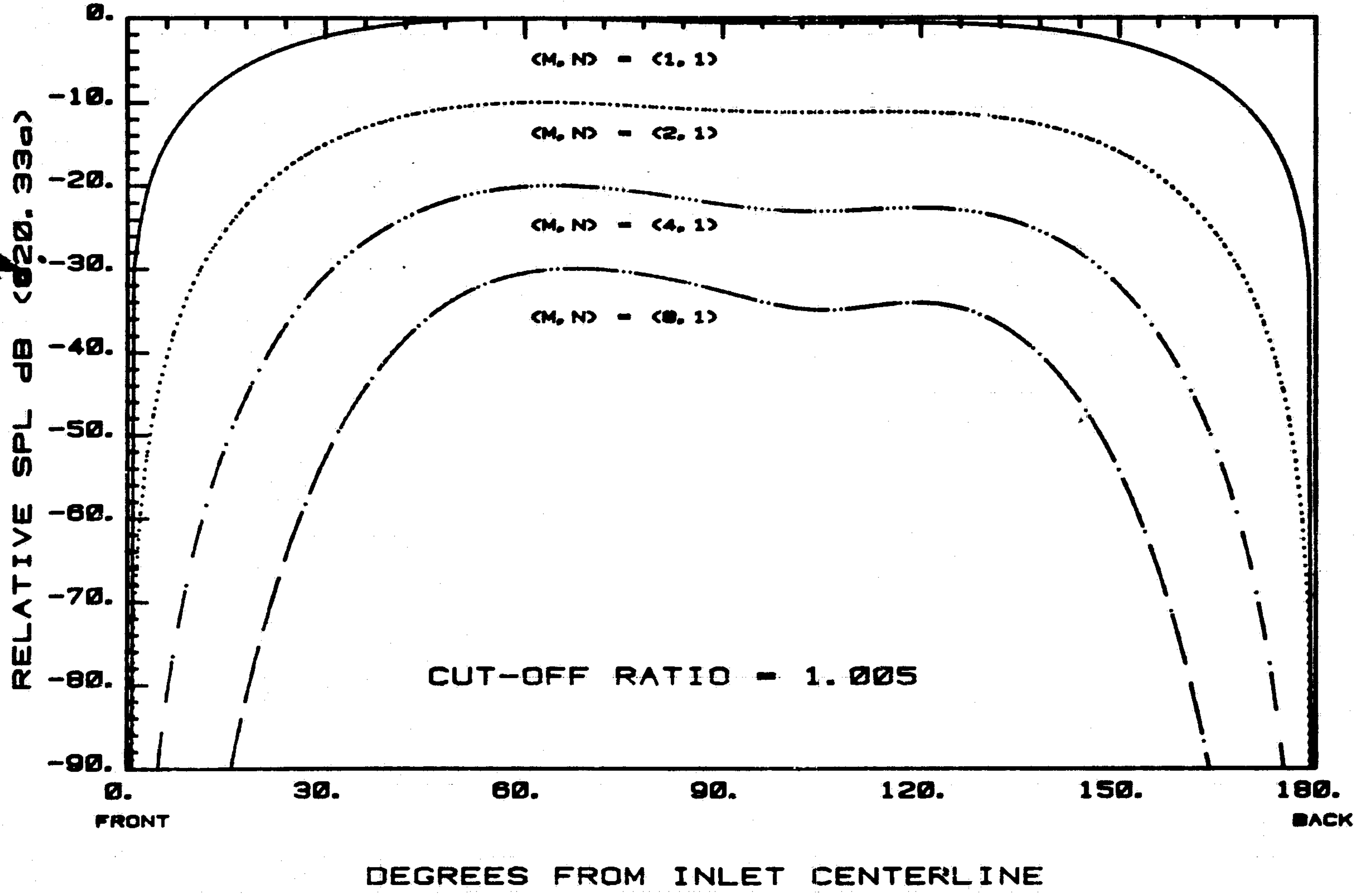

THIN LIPPED ELLIPTICAL INLET

Fig. 32b

ORIGINAL PAGE IS
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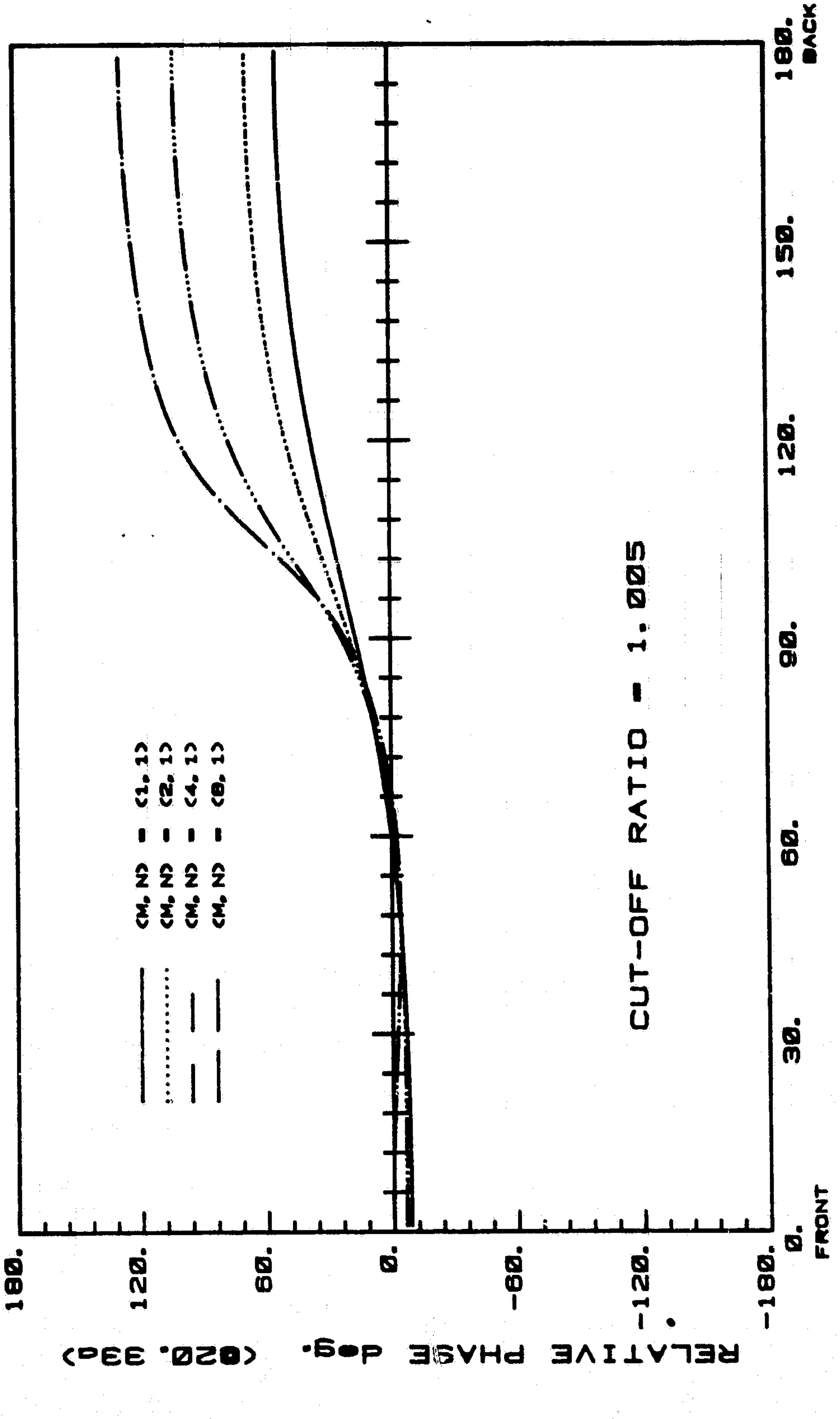

THIN LIPPED ELLIPTICAL INLET

Fig. 32c

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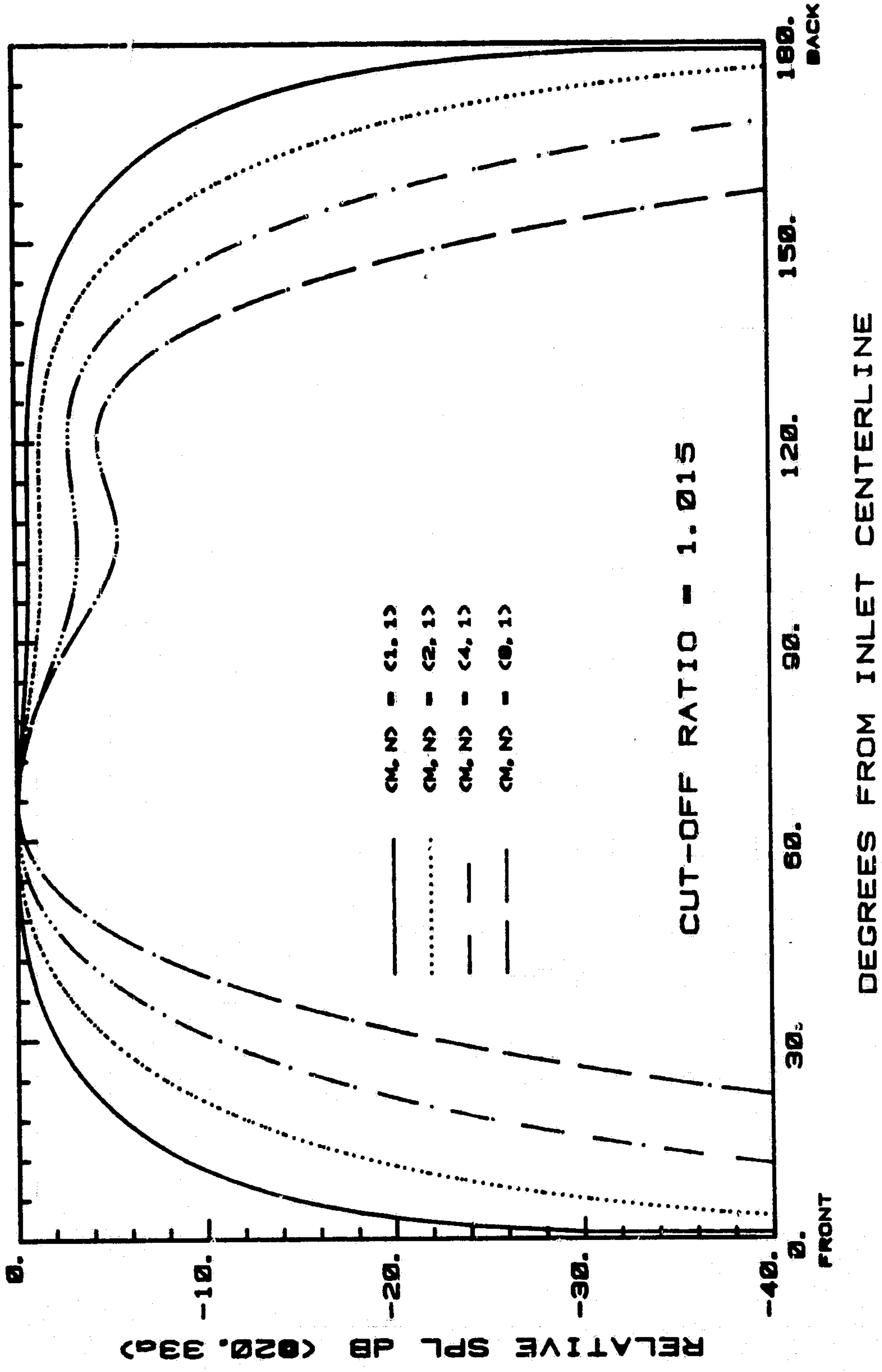

THIN LIPPED ELLIPTICAL INLET

Fig. 33e

ORIGINAL PAGE IS
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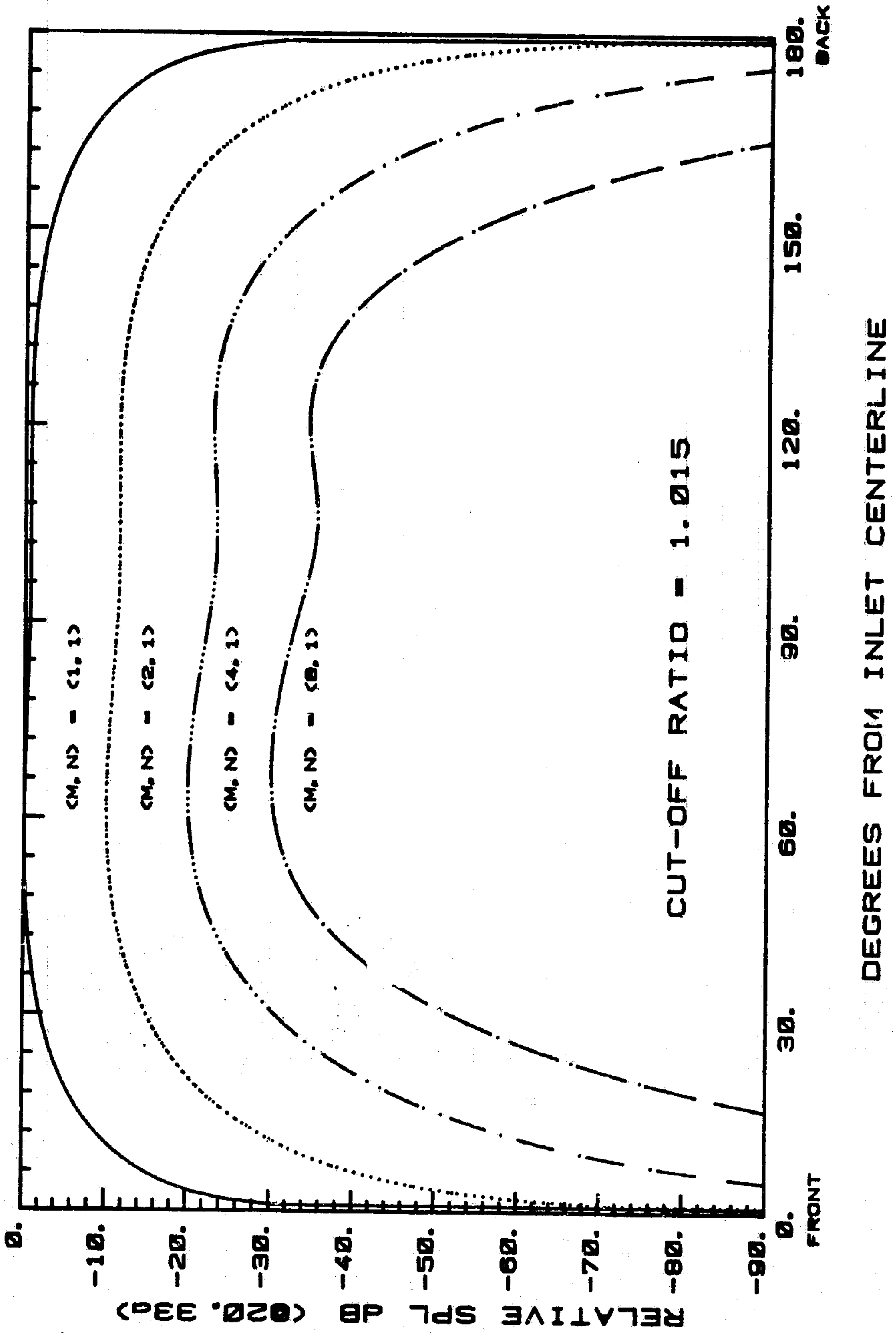
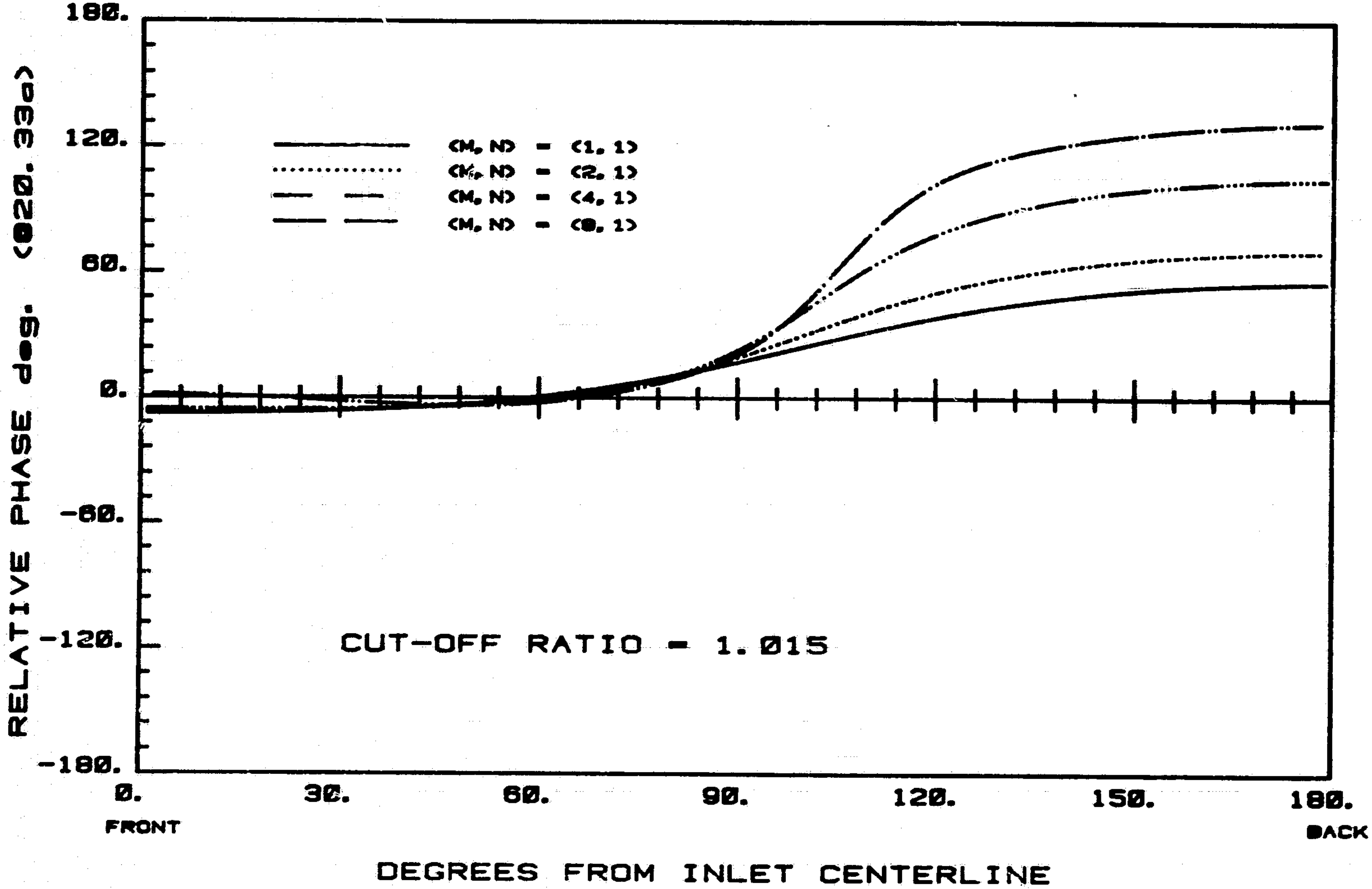


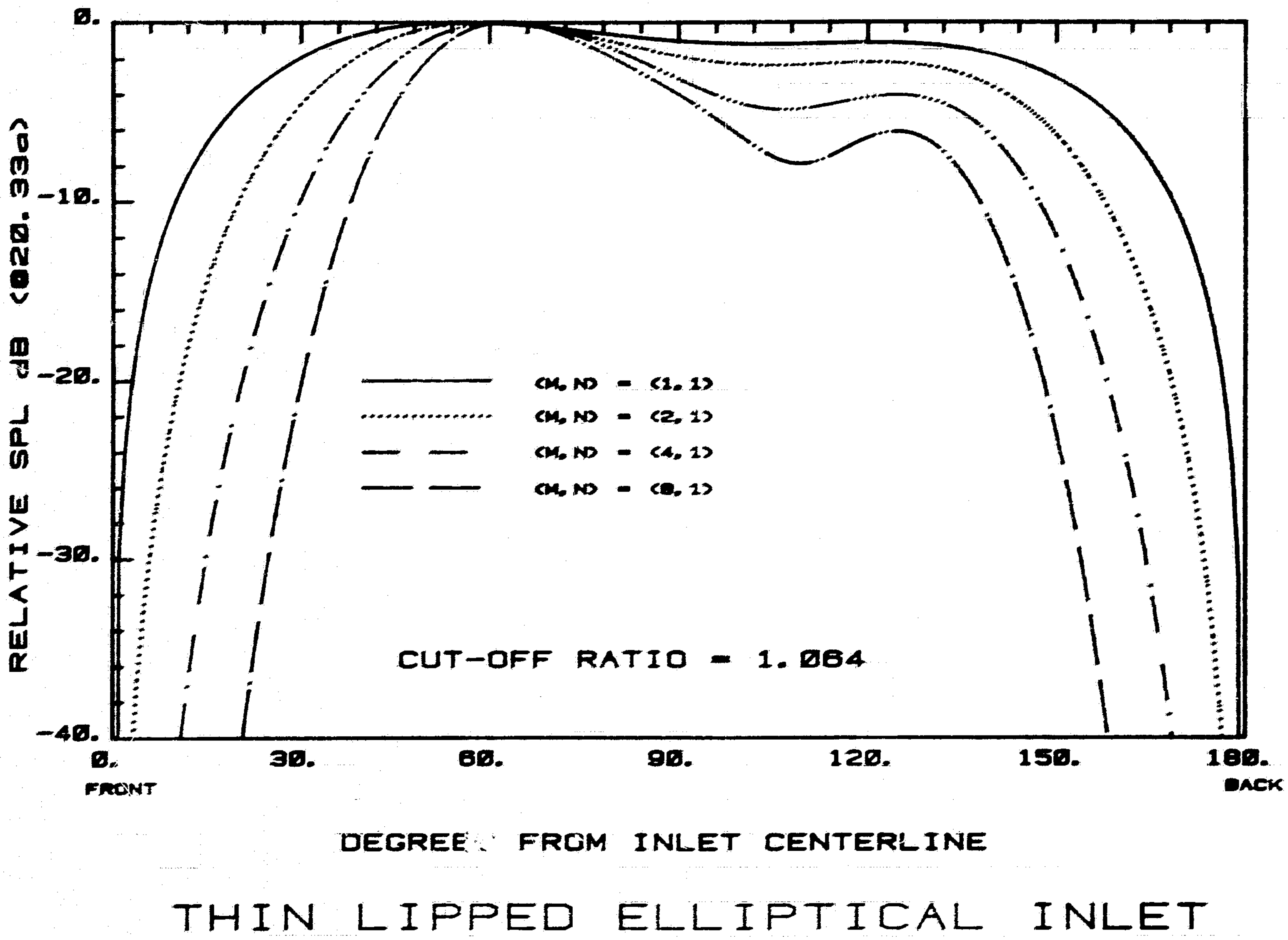
THIN LIPPED ELLIPTICAL INLET

Fig. 33b



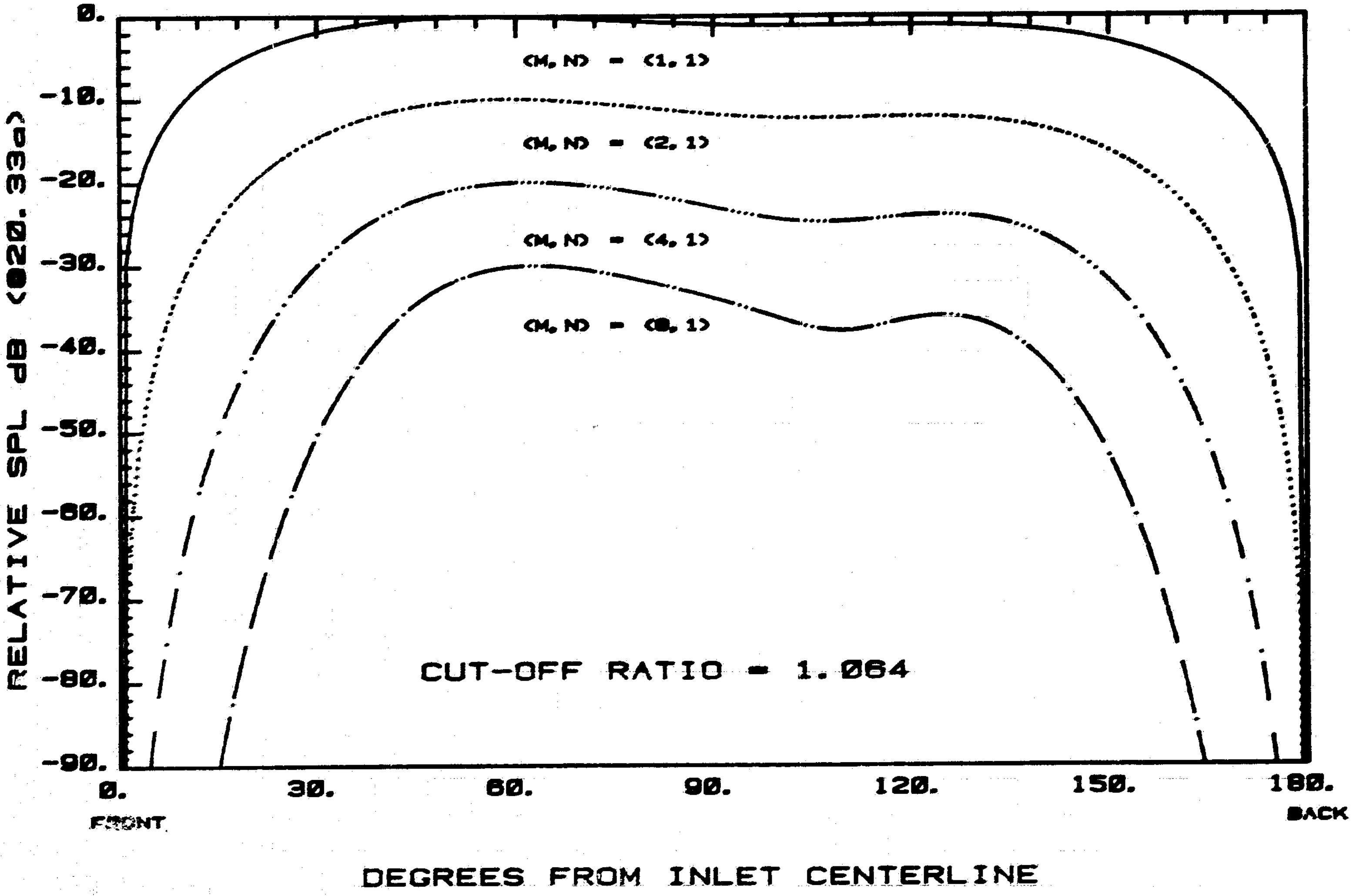
THIN LIPPED ELLIPTICAL INLET

Fig. 33c



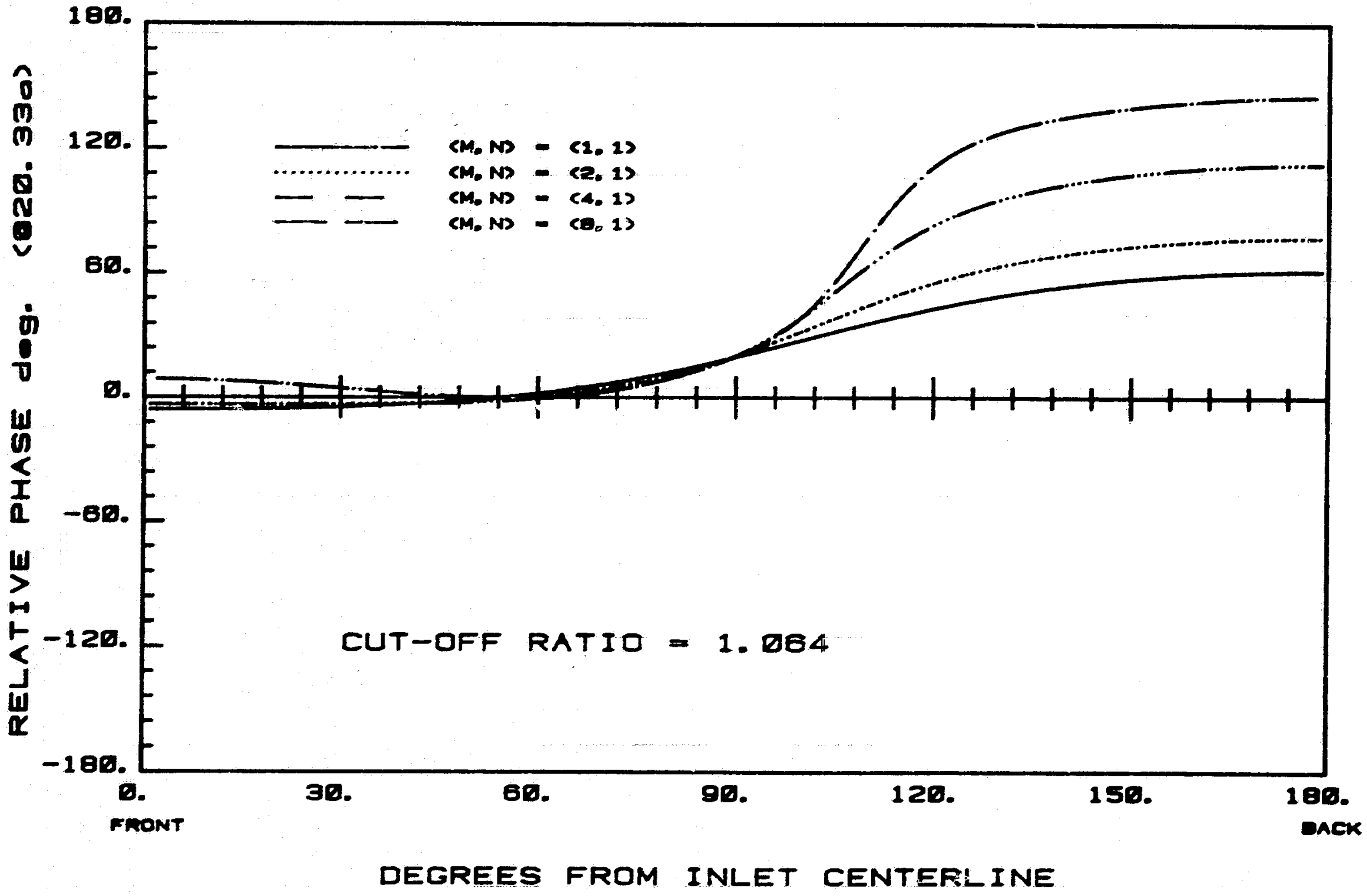
0.
-10.
-20.
-30.
-40.
RELATIVE SPL dB (020. 33a)
(M, N) = (1, 1)
(M, N) = (2, 1)
(M, N) = (4, 1)
(M, N) = (8, 1)
CUT-OFF RATIO = 1.064
0.
30.
60.
90.
120.
150.
180.
FRONT
BACK
DEGREES FROM INLET CENTERLINE
THIN LIPPED ELLIPTICAL INLET

Fig. 34a



THIN LIPPED ELLIPTICAL INLET

Fig. 34b

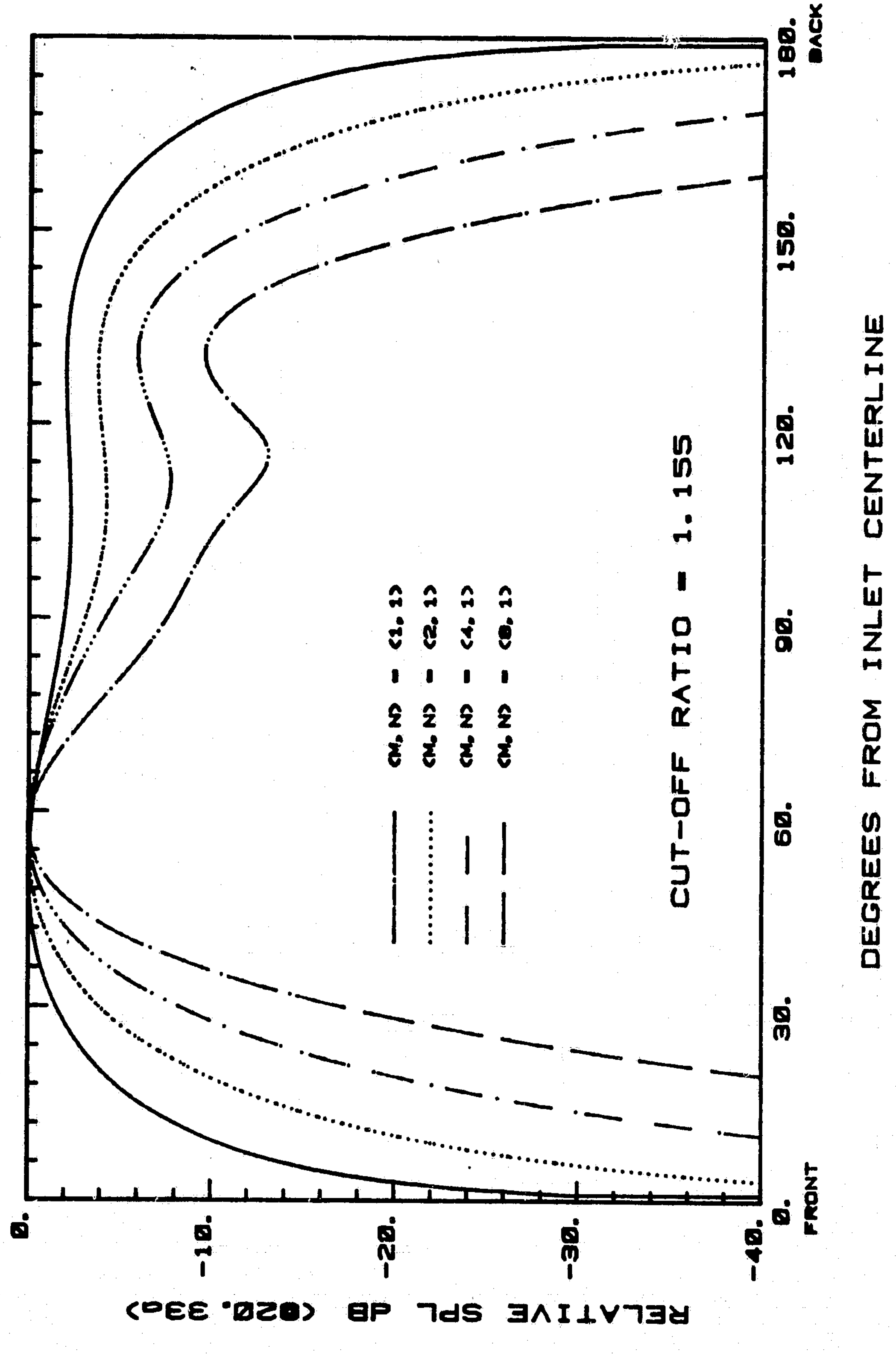


THIN LIPPED ELLIPTICAL INLET

Fig. 34c

ORIGINAL PAGE IS
OF POOR QUALITY

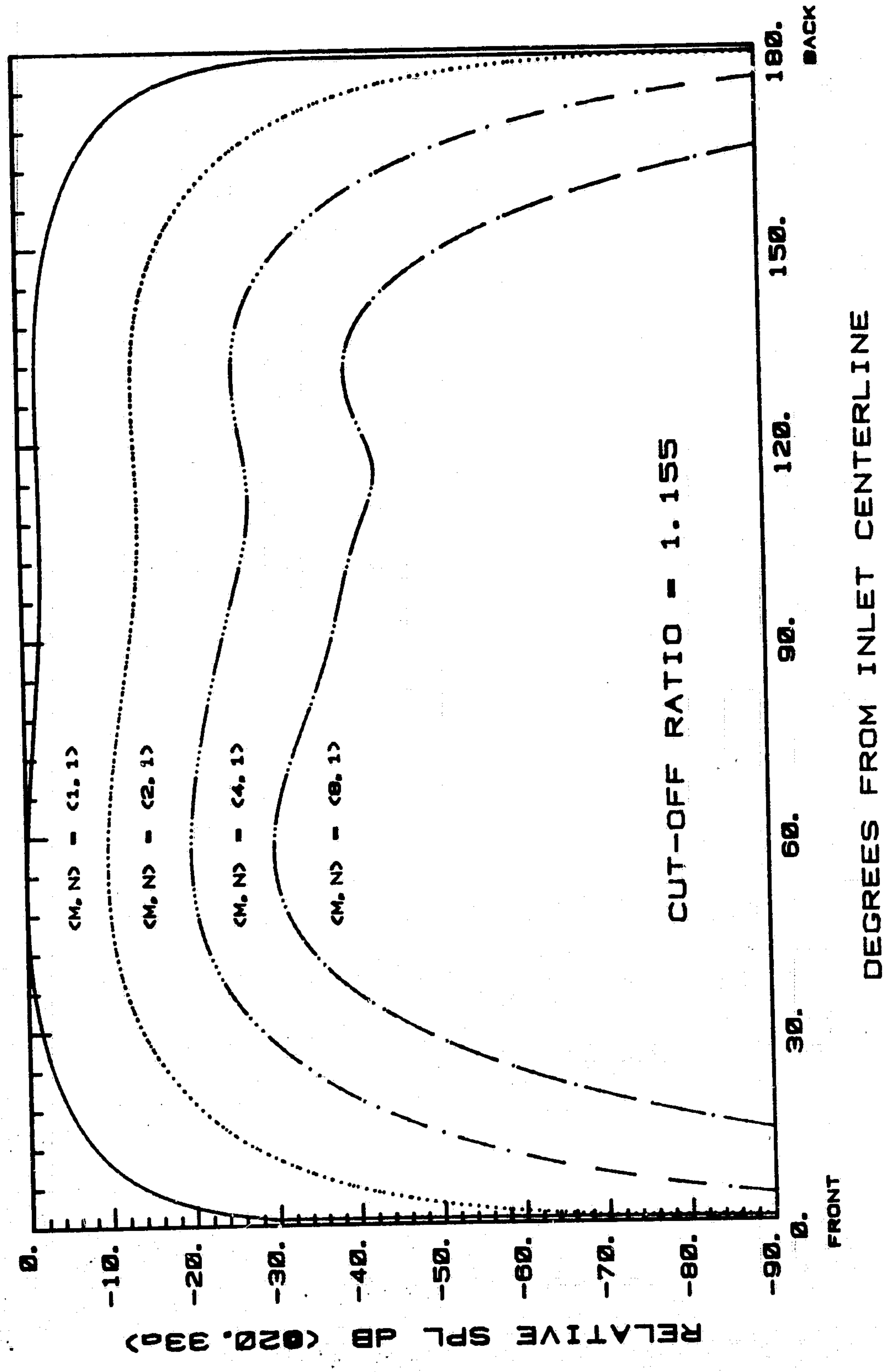
ORIGINAL PAGE IS
OF POOR QUALITY



THIN LIPPED ELLIPTICAL INLET

Fig. 35a

ORIGINAL PAGE IS OF POOR QUALITY



THIN LIPPED ELLIPTICAL INLET

Fig. 35b

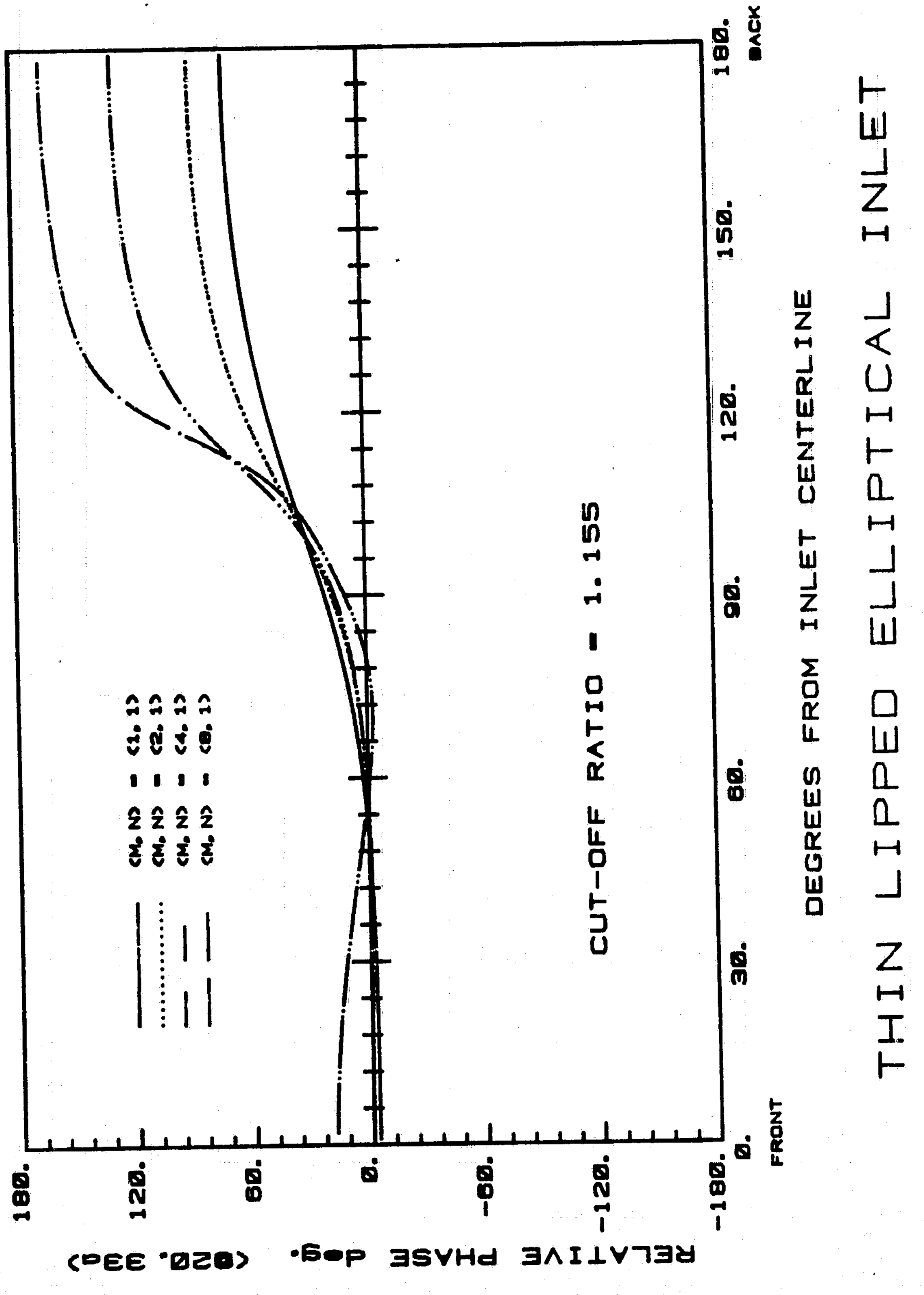
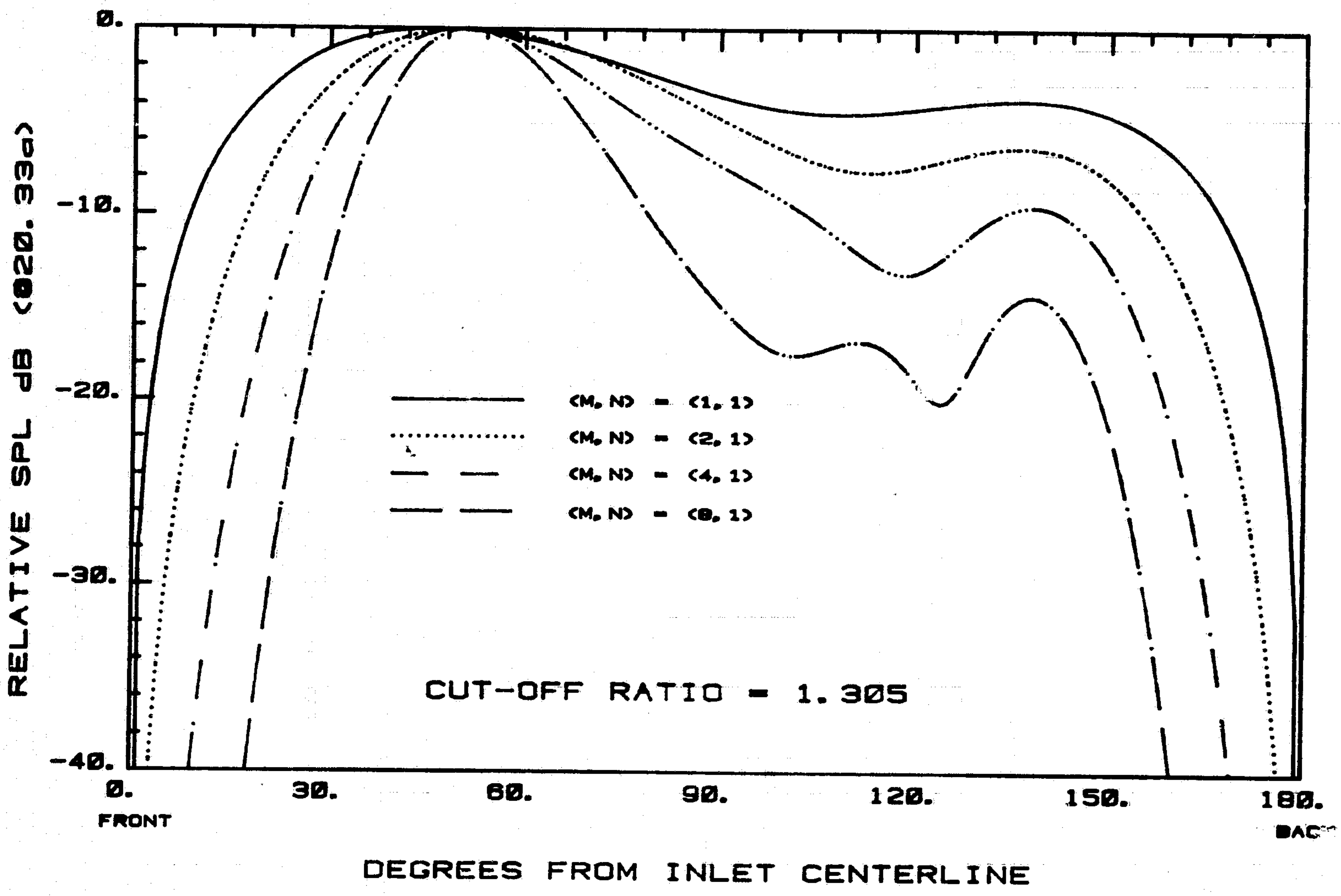
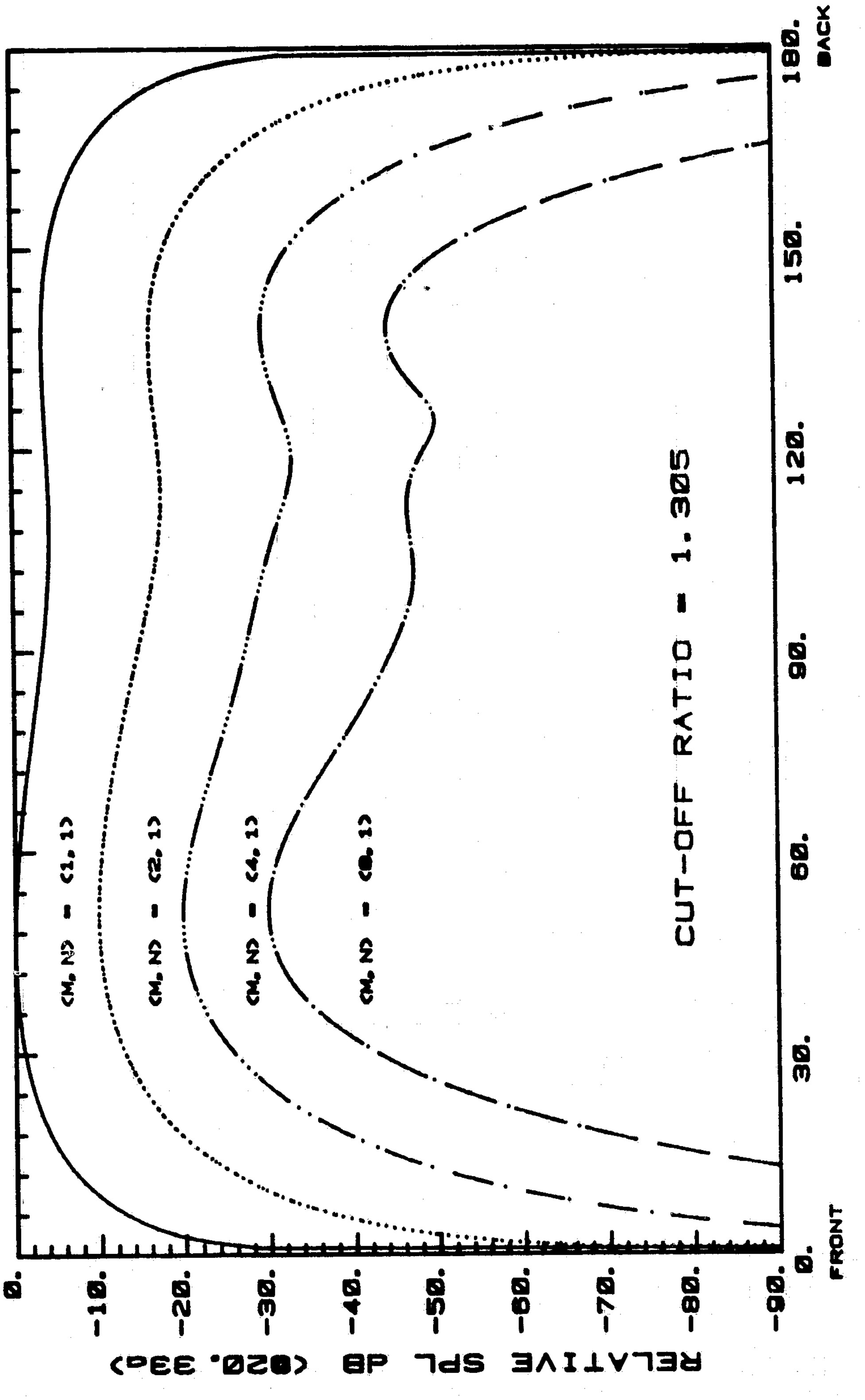

RELATIVE PHASE deg. (020.33d)
180.
120.
60.
0.
-60.
-120.
-180.
0.
30.
60.
90.
120.
150.
180.
FRONT
BACK
DEGREES FROM INLET CENTERLINE
(M, N) = (1, 1)
(M, N) = (2, 1)
(M, N) = (4, 1)
(M, N) = (8, 1)
CUT-OFF RATIO = 1.155
THIN LIPPED ELLIPTICAL INLET

Fig. 35c



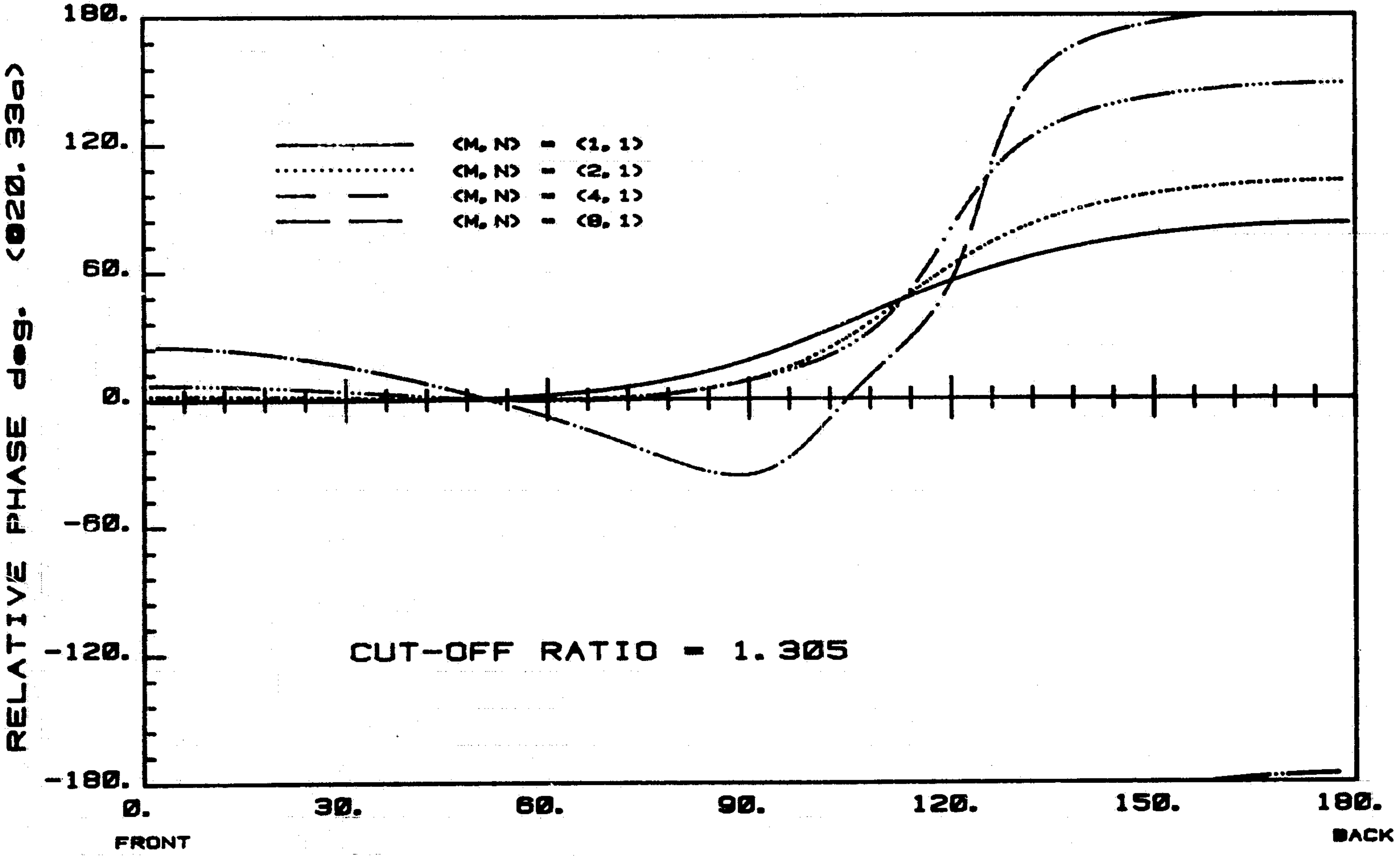
THIN LIPPED ELLIPTICAL INLET

Fig. 36a



THIN LIPPED ELLIPTICAL INLET

Fig. 36b



THIN LIPPED ELLIPTICAL INLET

Fig. 36c

ORIGINAL PAGE IS
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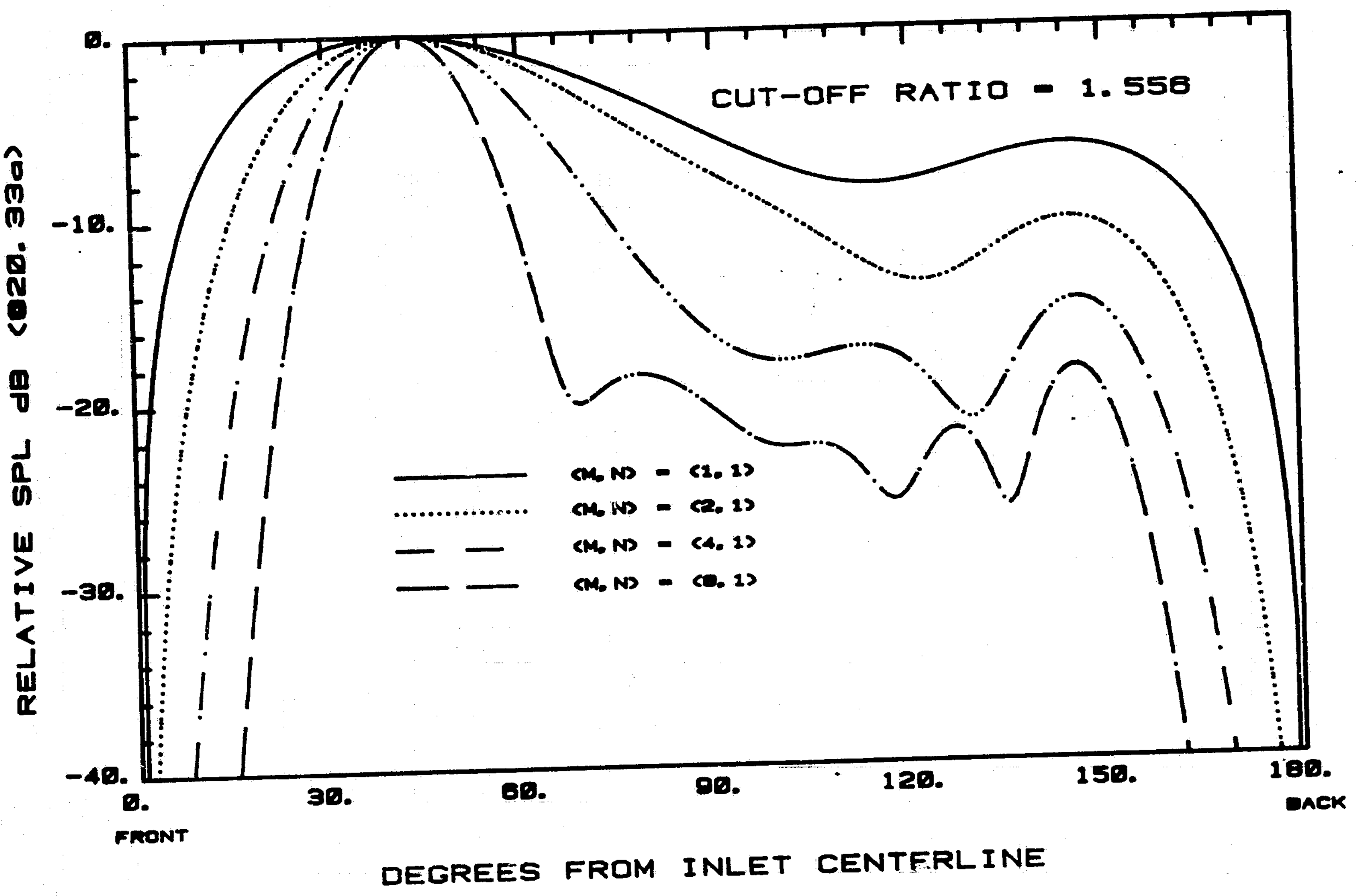
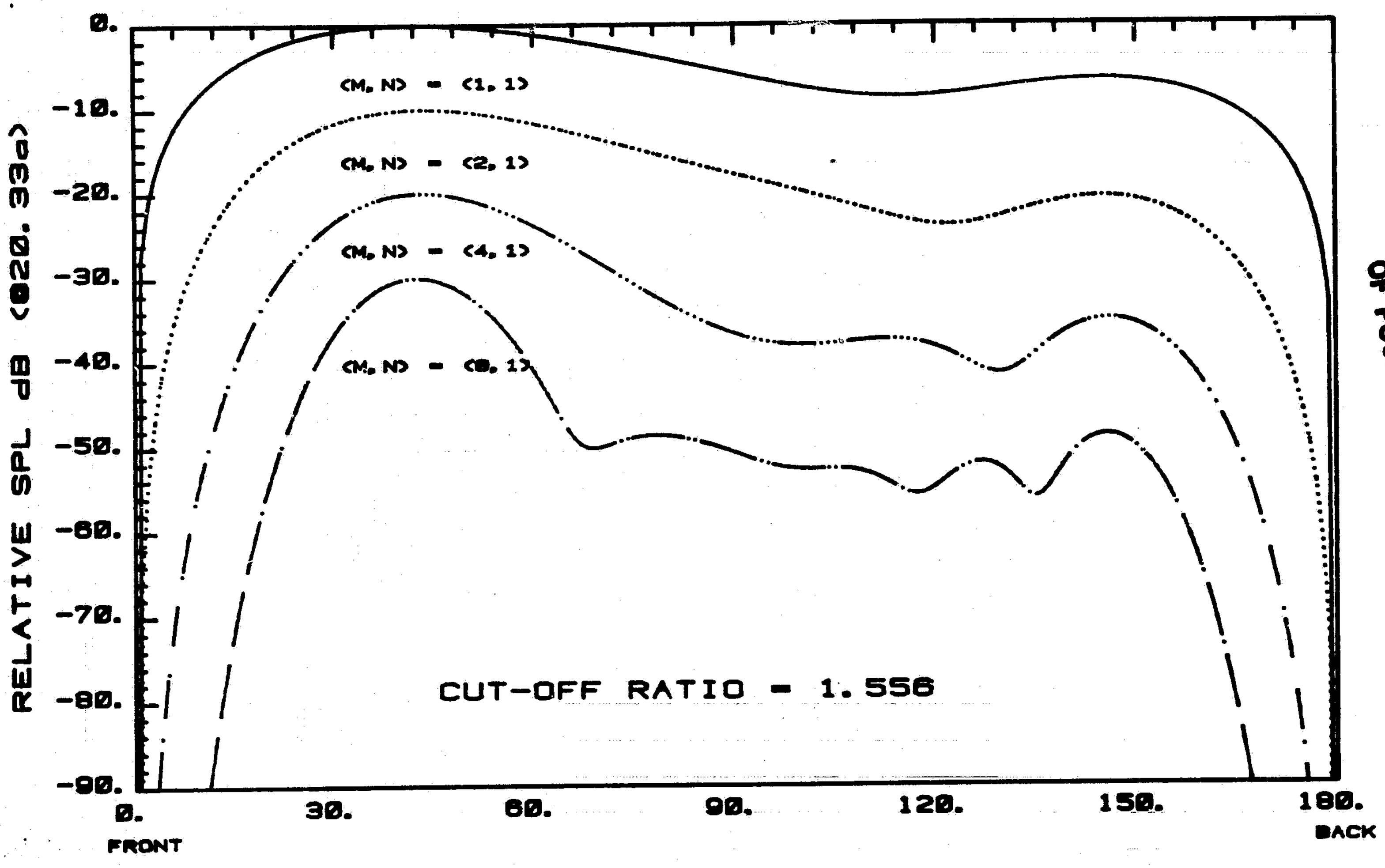


THIN LIPPED ELLIPTICAL INLET

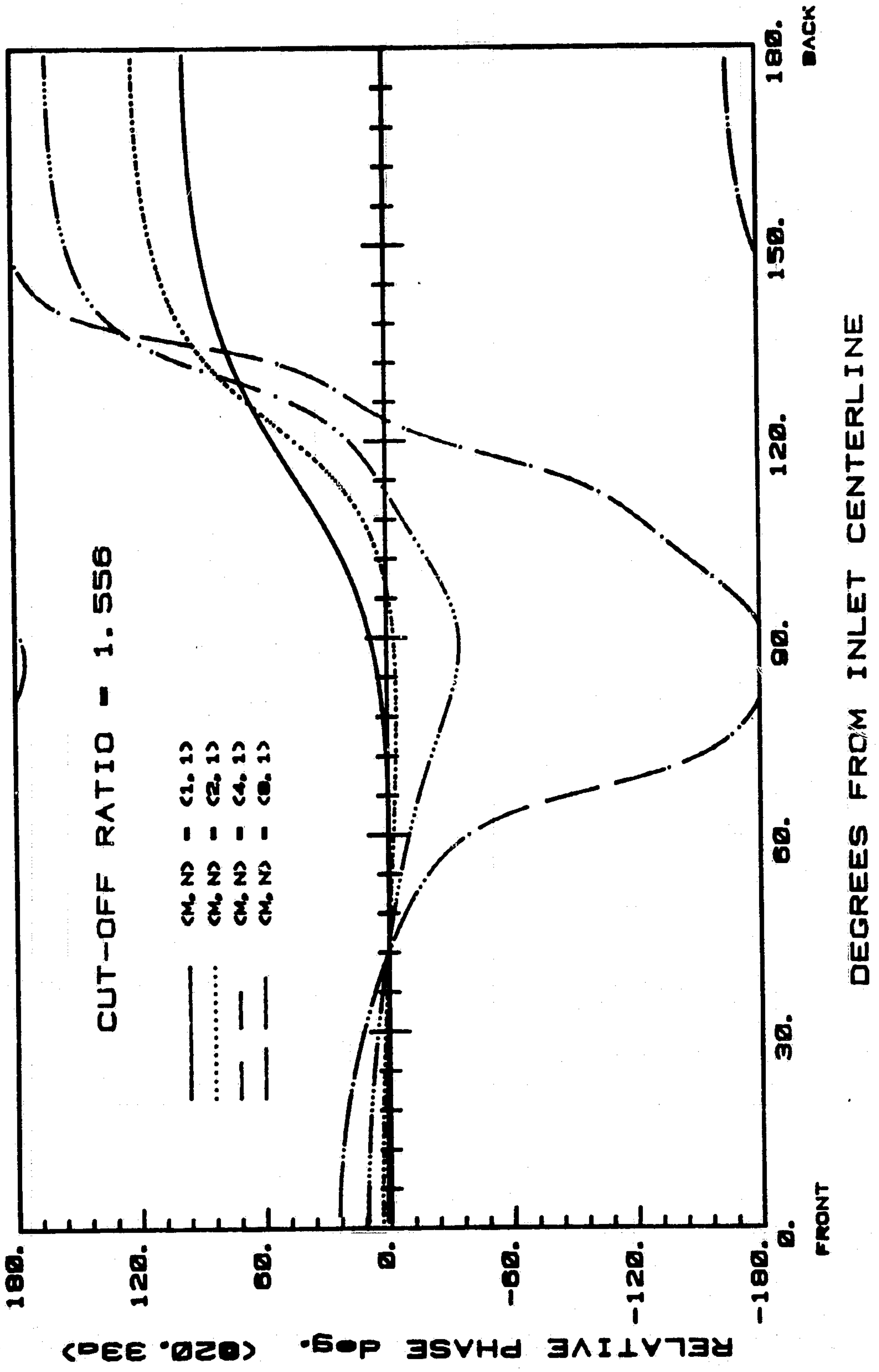
Fig. 37a



THIN LIPPED ELLIPTICAL INLET

Fig. 37b

ORIGINAL PAGE IS
OF POOR QUALITY



THIN LIPPED ELLIPTICAL INLET

Fig. 37c

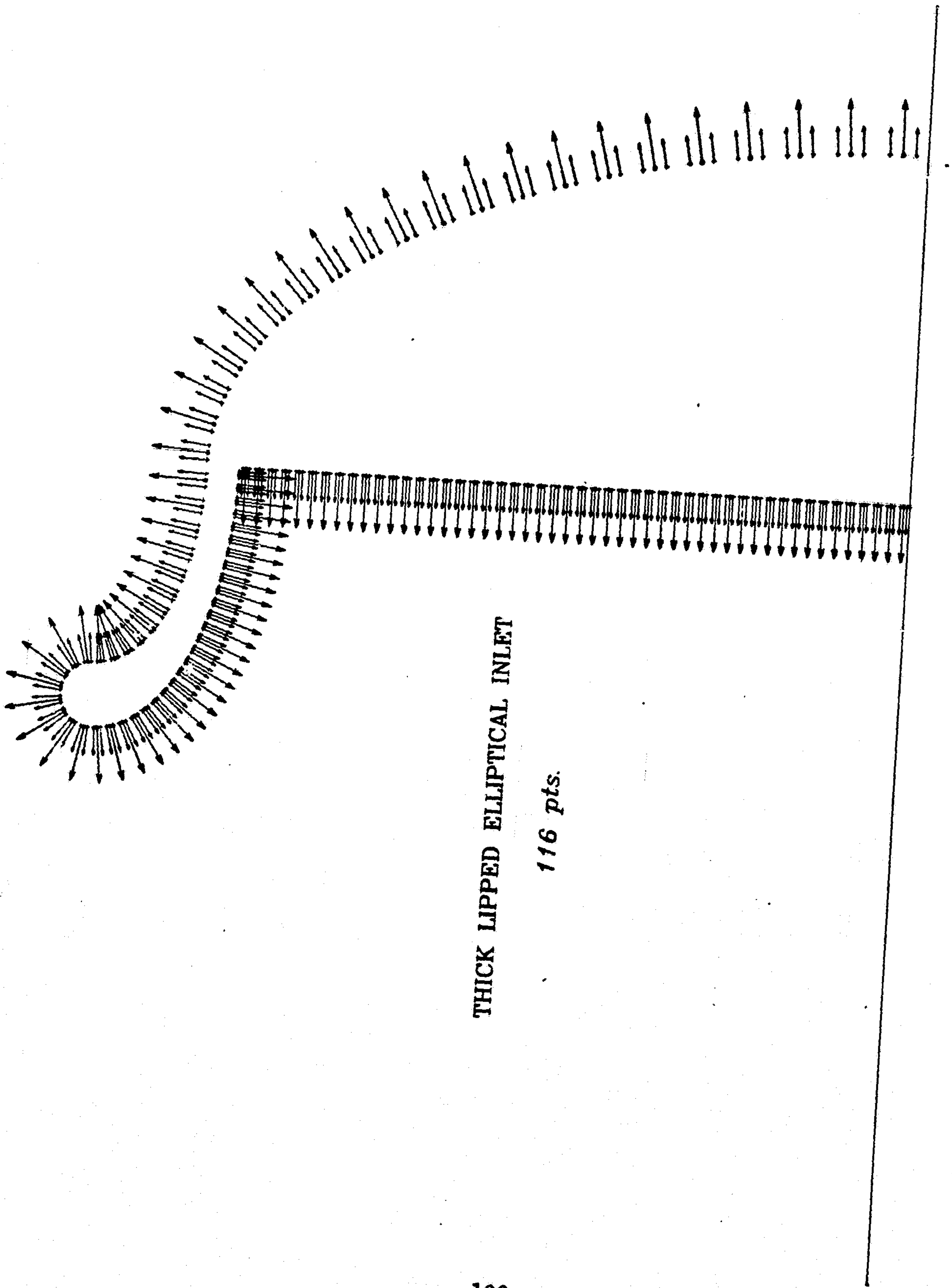


Fig. 38

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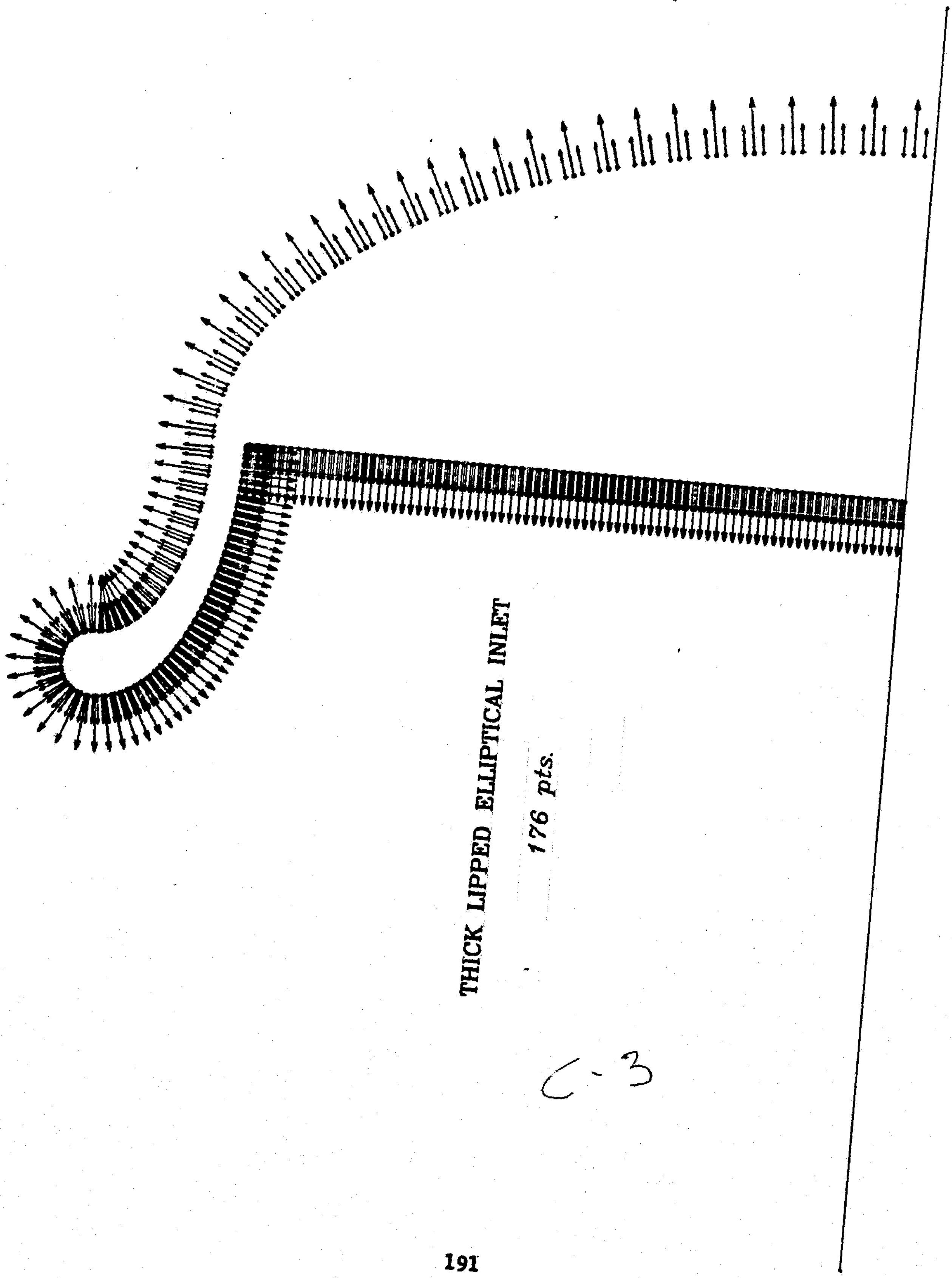

THICK LIPPED ELLIPTICAL INLET

176 pts.

Fig. 39

C-3

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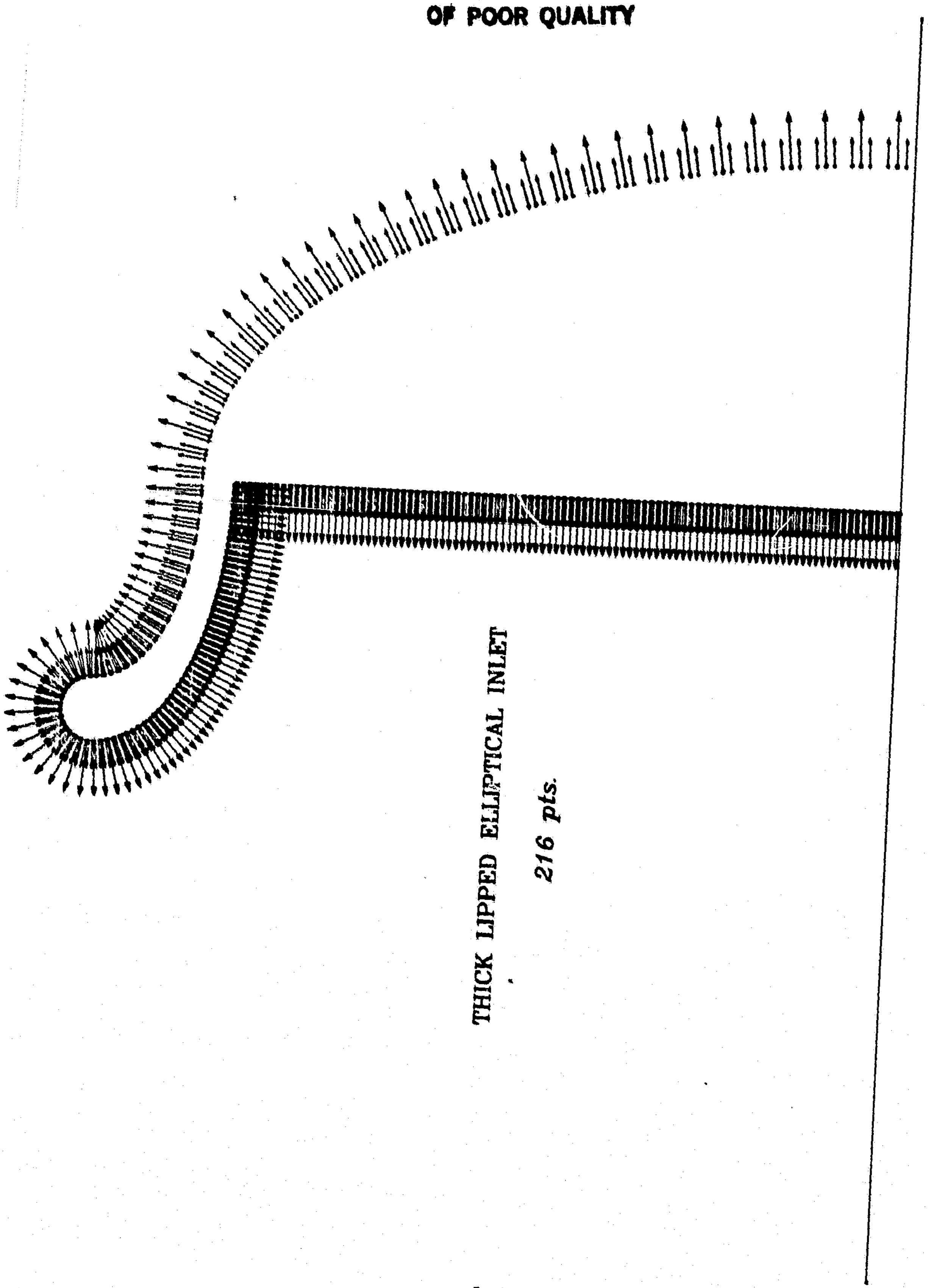


THICK LIPPED ELLIPTICAL INLET

216 pts.

Fig. 40

THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	102
2	79	48	102
4	85	50	102
6	89	52	102
8	91	54	102
10	93	56	102
12	94	58	102
14	96	60	102
16	97	62	102
18	97	64	102
20	98	66	102
22	99	68	102
24	99	70	102
26	100	72	102
28	100	74	101
30	101	76	101
32	101	78	101
34	101	80	101
36	102	82	101
38	102	84	101
40	102	86	101
42	102	88	101
44	102	90	100

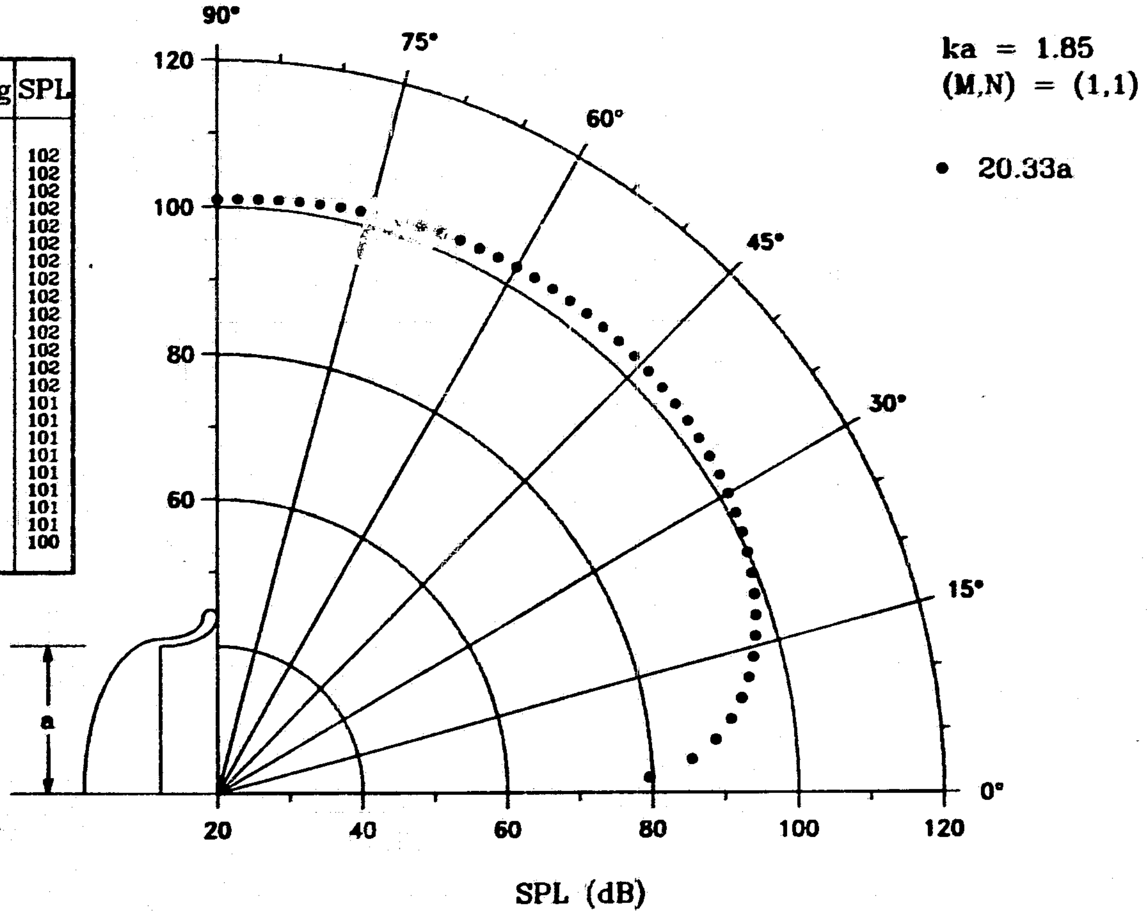


Fig. 41a

THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	103
2	79	48	103
4	85	50	103
6	89	52	103
8	91	54	103
10	93	56	103
12	95	58	103
14	96	60	102
16	97	62	102
18	98	64	102
20	99	66	102
22	99	68	102
24	100	70	102
26	100	72	102
28	101	74	102
30	101	76	102
32	101	78	101
34	102	80	101
36	102	82	101
38	102	84	101
40	102	86	101
42	102	88	101
44	102	90	101

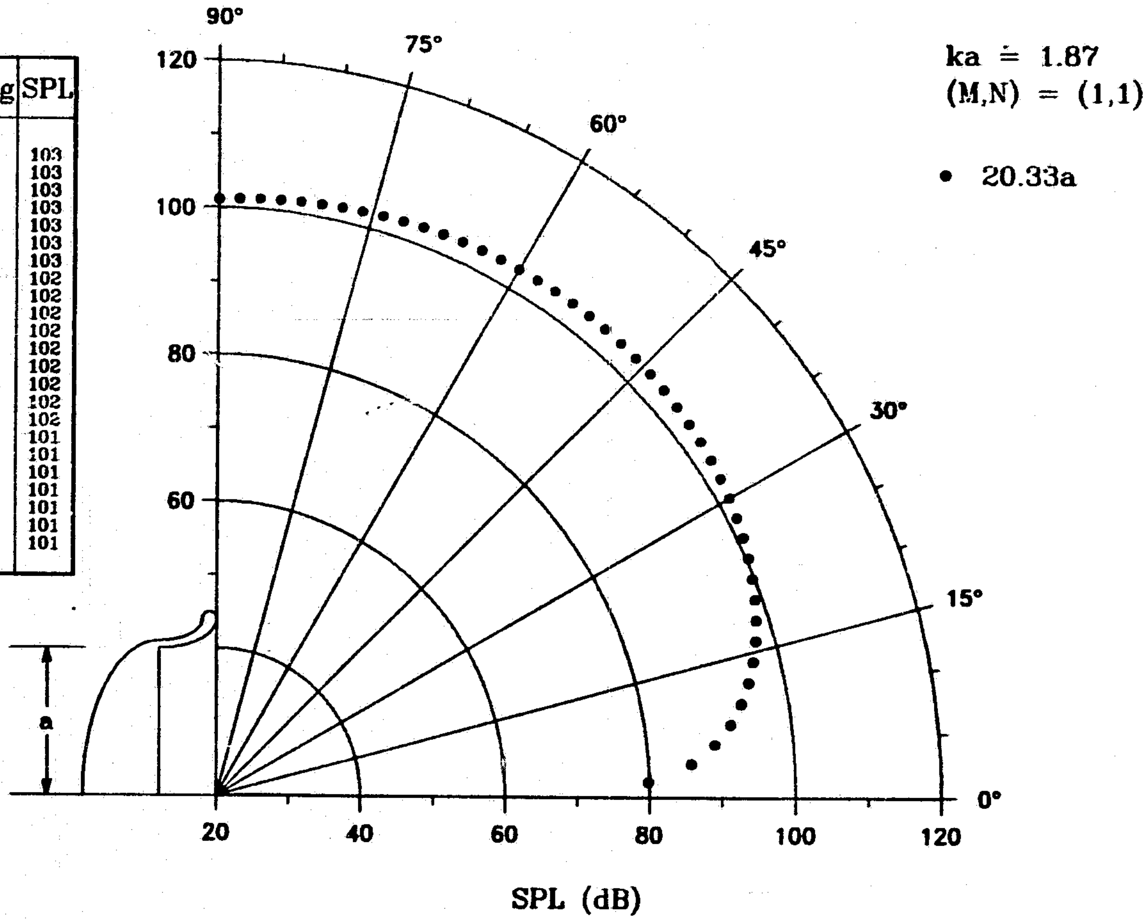
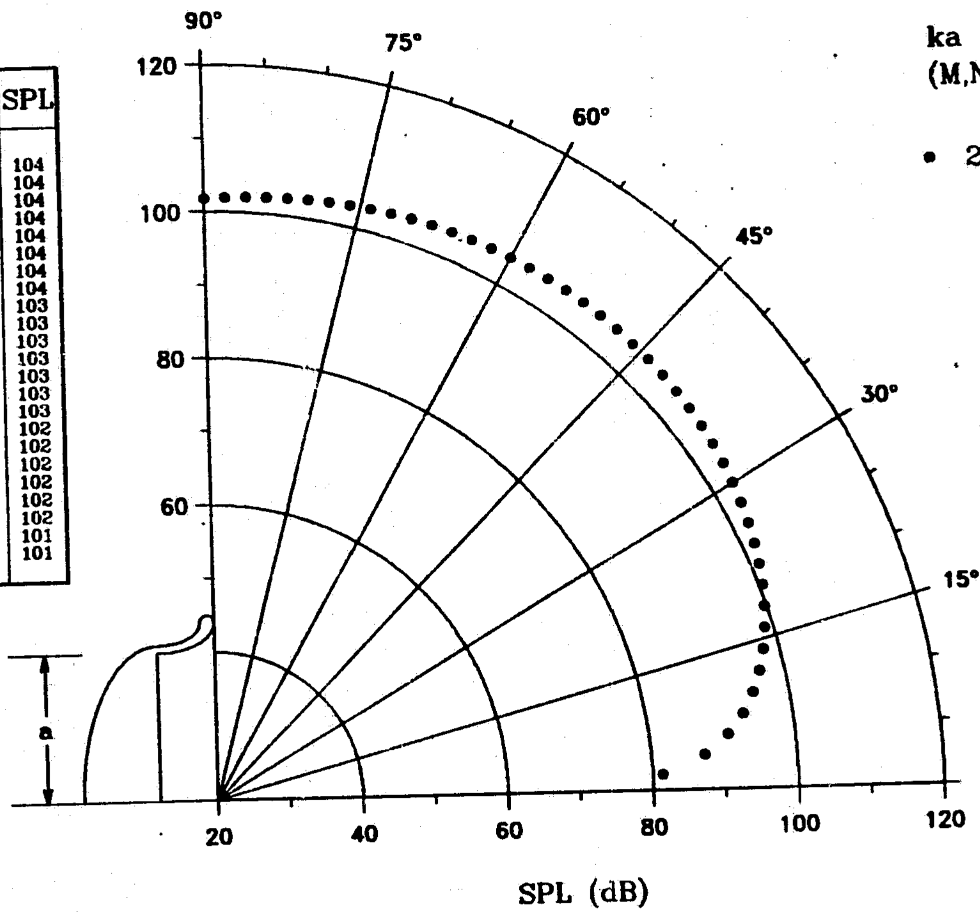


Fig. 41b

THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	104
2	81	48	104
4	87	50	104
6	90	52	104
8	93	54	104
10	95	56	104
12	96	58	104
14	97	60	104
16	98	62	103
18	99	64	103
20	100	66	103
22	101	68	103
24	101	70	103
26	102	72	103
28	102	74	103
30	102	76	102
32	103	78	102
34	103	80	102
36	103	82	102
38	103	84	102
40	104	86	102
42	104	88	101
44	104	90	101



ka = 1.96
(M,N) = (1,1)

• 20.33a

Fig. 41c

THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	106
2	83	48	106
4	89	50	106
6	93	52	106
8	95	54	106
10	97	56	106
12	99	58	106
14	100	60	106
16	101	62	105
18	102	64	105
20	103	66	105
22	103	68	105
24	104	70	105
26	104	72	105
28	105	74	104
30	105	76	104
32	105	78	104
34	105	80	104
36	106	82	103
38	106	84	103
40	106	86	103
42	106	88	103
44	106	90	103

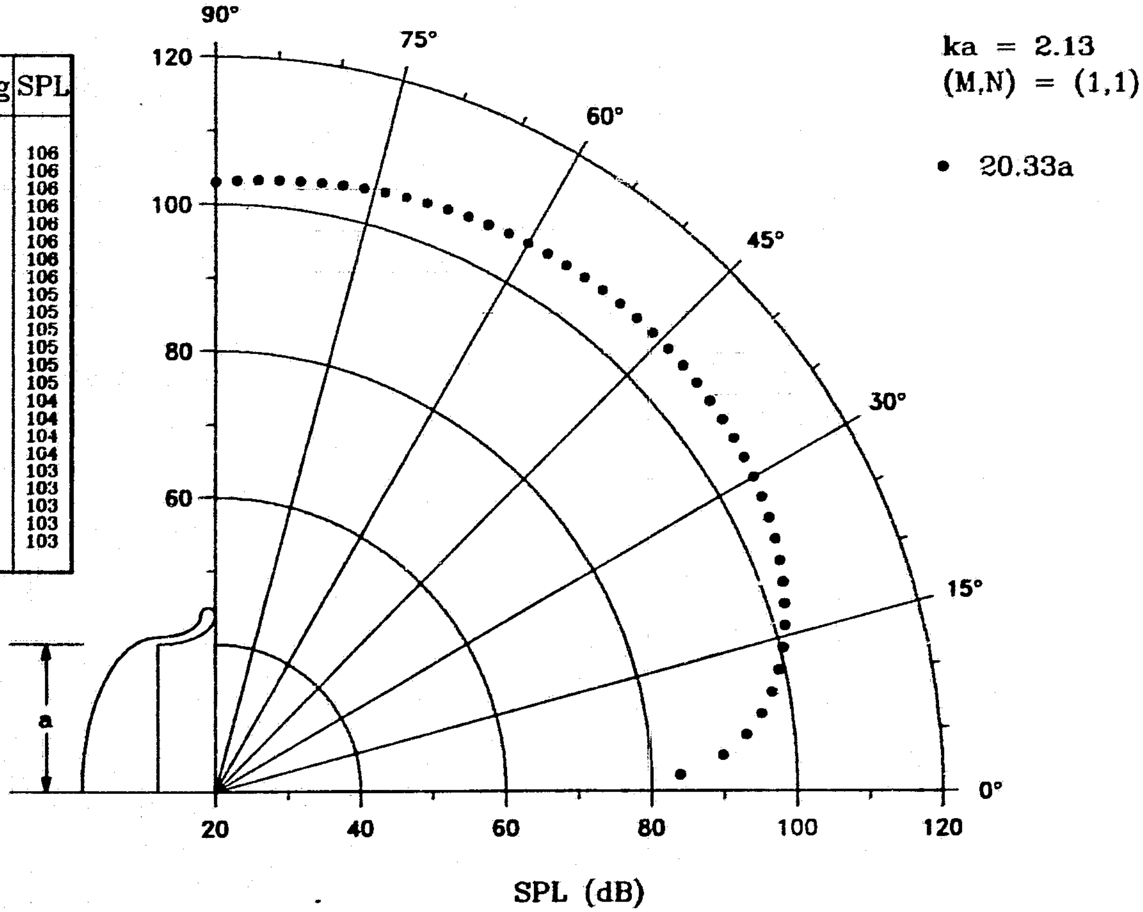
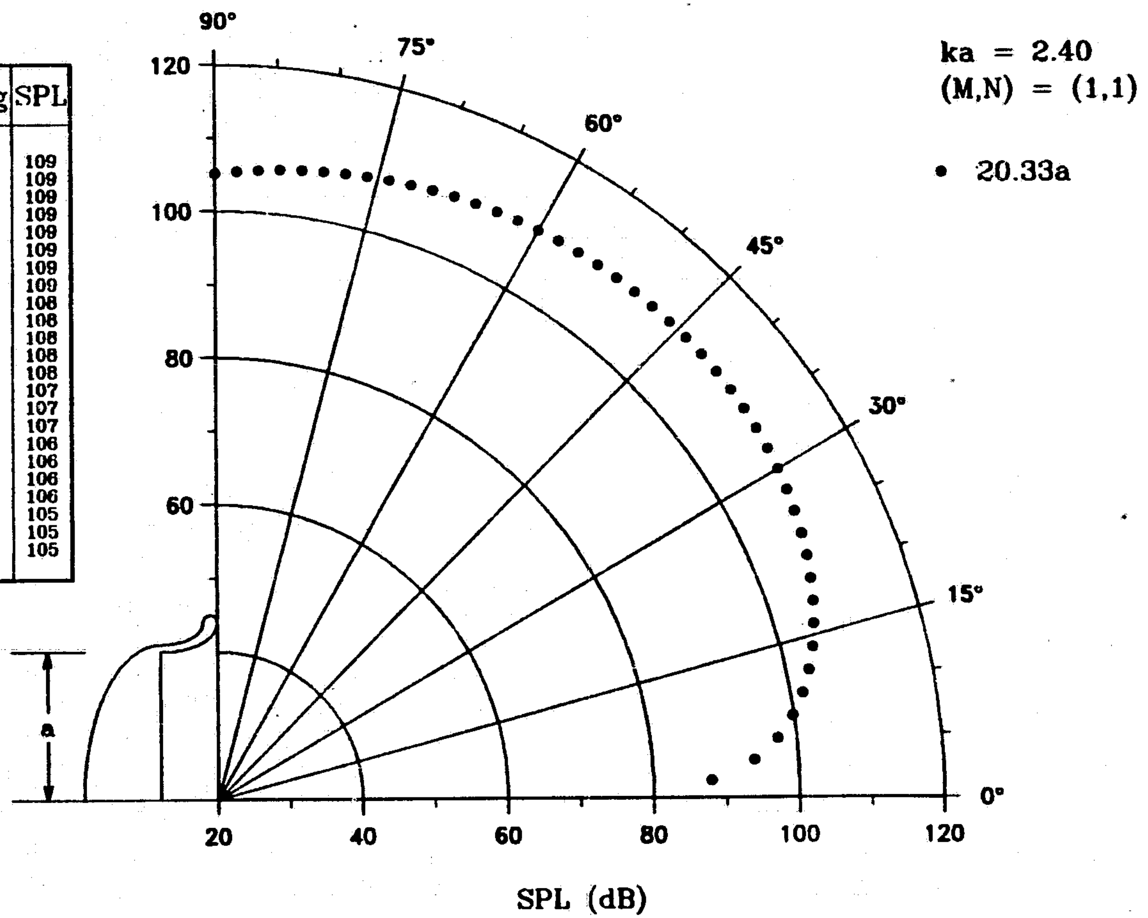


Fig. 41d

THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	109
2	87	48	109
4	93	50	109
6	97	52	109
8	99	54	109
10	101	56	109
12	103	58	109
14	104	60	109
16	105	62	108
18	106	64	108
20	106	66	108
22	107	68	108
24	107	70	108
26	108	72	107
28	108	74	107
30	109	76	107
32	109	78	106
34	109	80	106
36	109	82	106
38	109	84	106
40	109	86	105
42	109	88	105
44	109	90	105



ka = 2.40
(M,N) = (1,1)

• 20.33a

Fig. 41e

THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	114
2	94	48	114
4	100	50	114
6	103	52	114
8	105	54	113
10	107	56	113
12	109	58	113
14	110	60	113
16	111	62	112
18	112	64	112
20	112	66	112
22	113	68	112
24	113	70	111
26	114	72	111
28	114	74	111
30	114	76	110
32	114	78	110
34	114	80	110
36	114	82	109
38	114	84	109
40	114	86	109
42	114	88	108
44	114	90	108

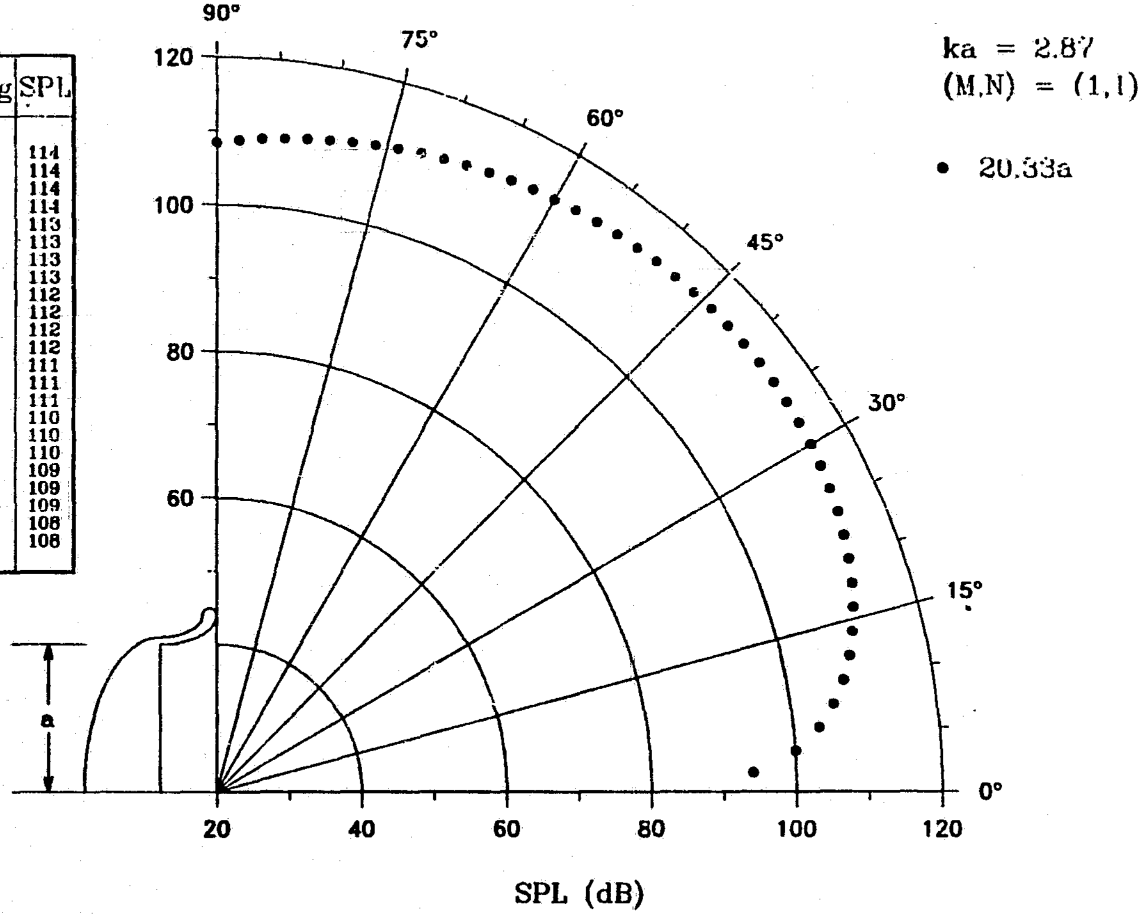


Fig. 41f

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THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	120
2	103	48	120
4	109	50	119
6	112	52	119
8	115	54	118
10	116	56	118
12	118	58	117
14	119	60	117
16	120	62	116
18	120	64	116
20	121	66	115
22	121	68	114
24	122	70	114
26	122	72	113
28	122	74	113
30	122	76	112
32	122	78	112
34	122	80	111
36	122	82	111
38	122	84	110
40	121	86	110
42	121	88	110
44	121	90	109

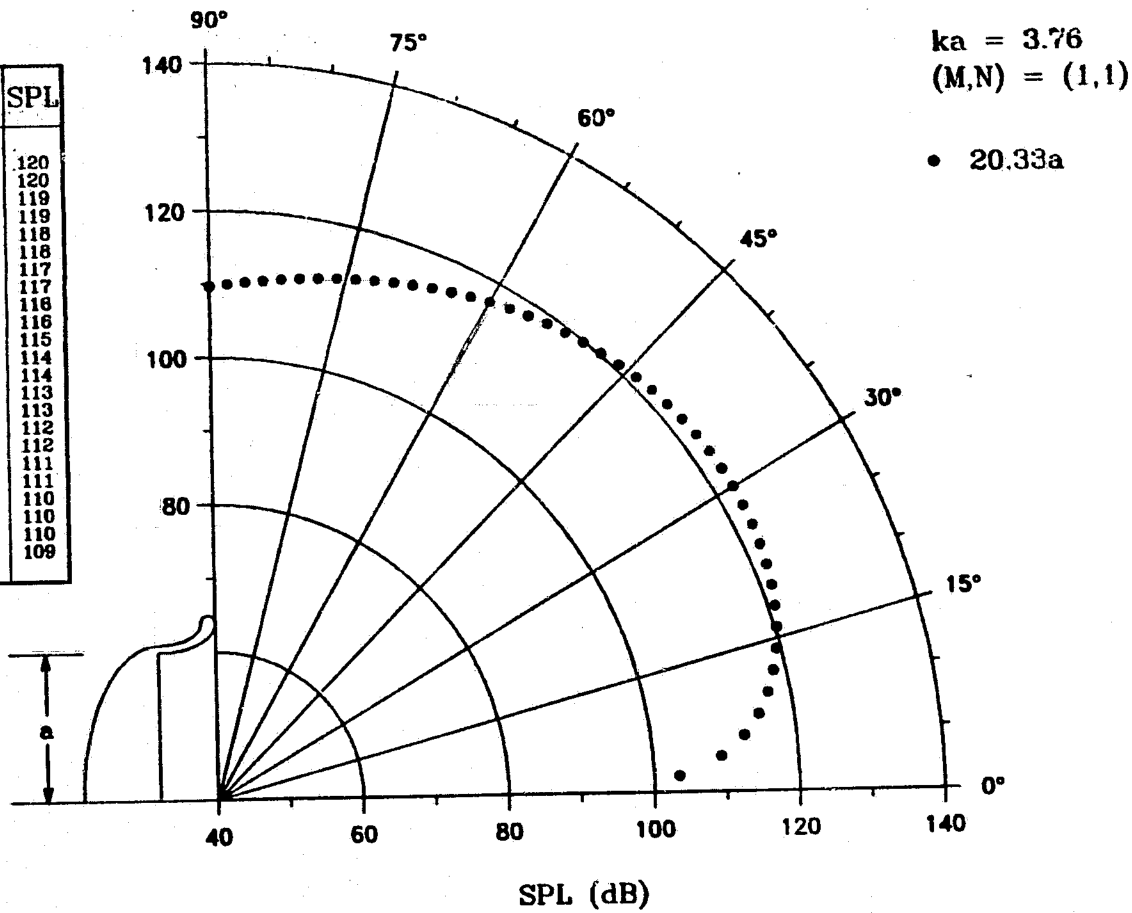
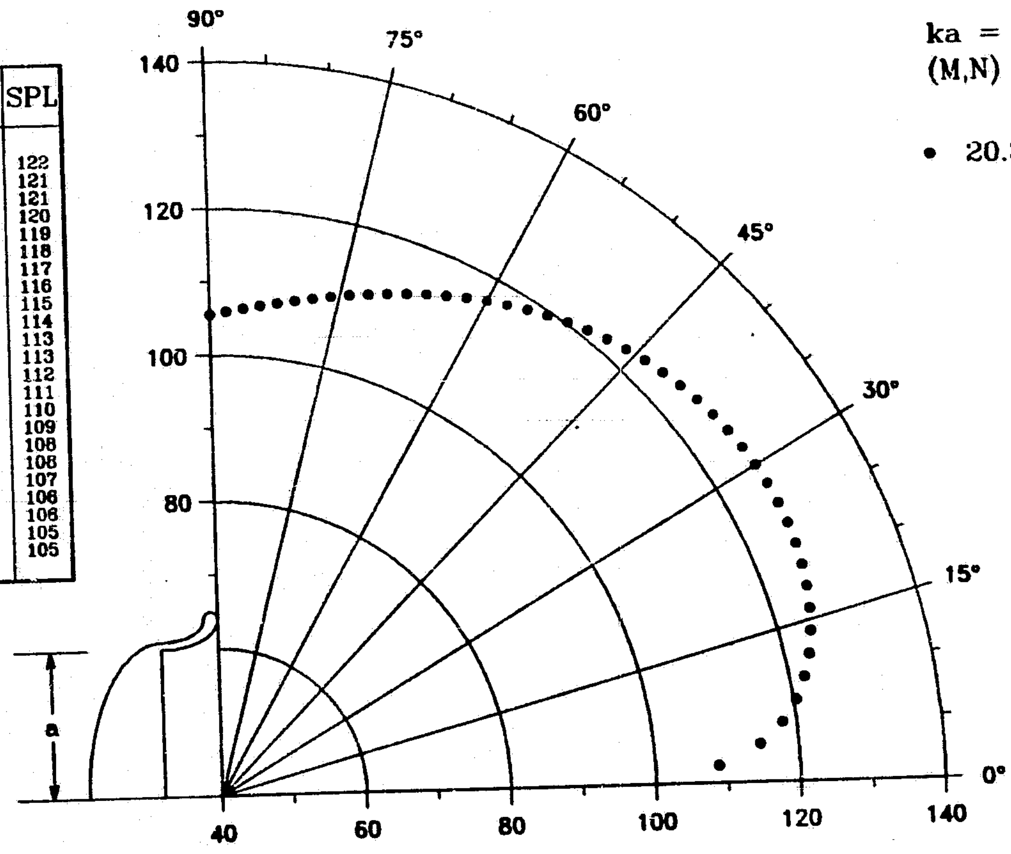


Fig. 41g

THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	122
2	108	48	121
4	114	50	121
6	118	52	120
8	120	54	119
10	122	56	118
12	123	58	117
14	124	60	116
16	125	62	115
18	125	64	114
20	126	66	113
22	126	68	113
24	126	70	112
26	126	72	111
28	126	74	110
30	126	76	109
32	126	78	108
34	125	80	108
36	125	82	107
38	124	84	106
40	124	86	106
42	123	88	105
44	123	90	105



ka = 4.60
(M,N) = (1,1)

• 20.33a

Fig. 41h

THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	122
2	112	48	120
4	118	50	119
6	121	52	118
8	123	54	117
10	125	56	115
12	126	58	114
14	127	60	113
16	128	62	111
18	128	64	109
20	128	66	108
22	129	68	107
24	129	70	106
26	128	72	106
28	128	74	105
30	128	76	105
32	127	78	105
34	127	80	105
36	126	82	105
38	125	84	105
40	125	86	105
42	124	88	105
44	123	90	105

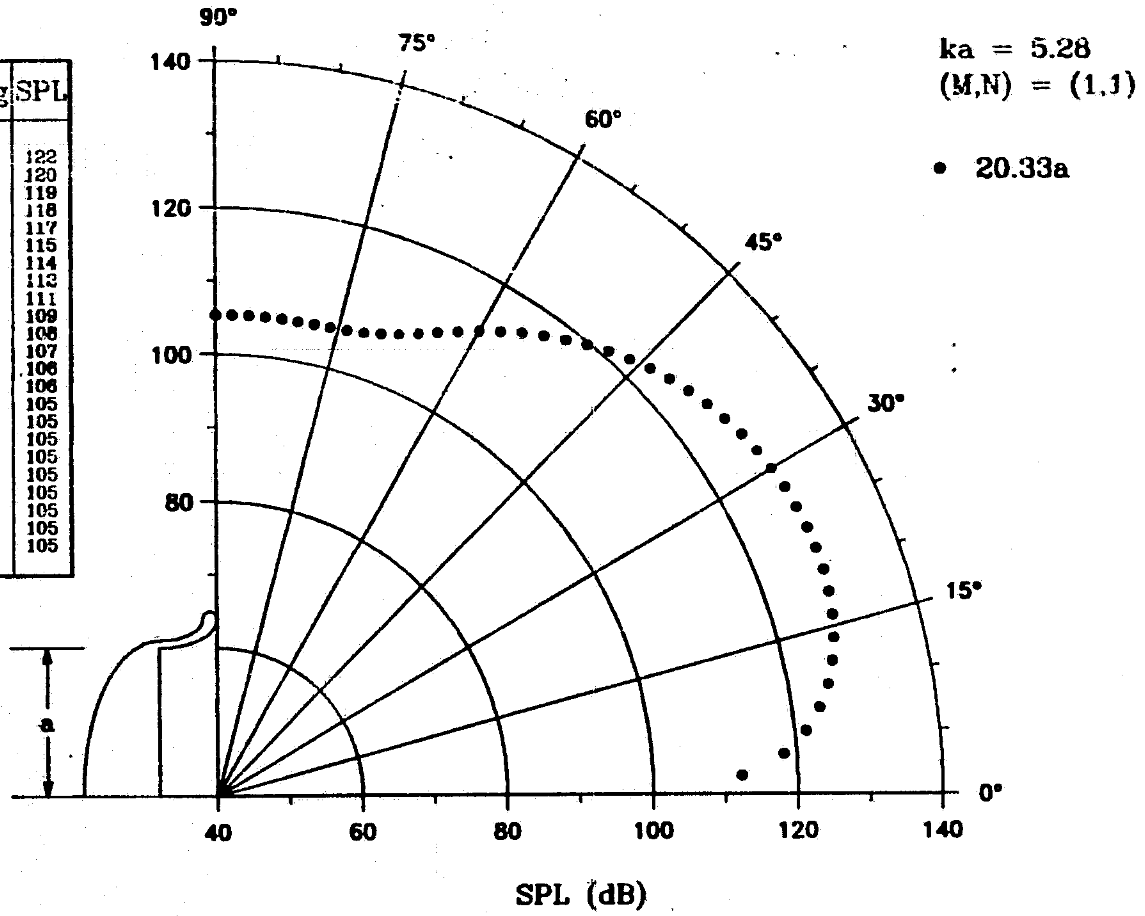


Fig. 41i

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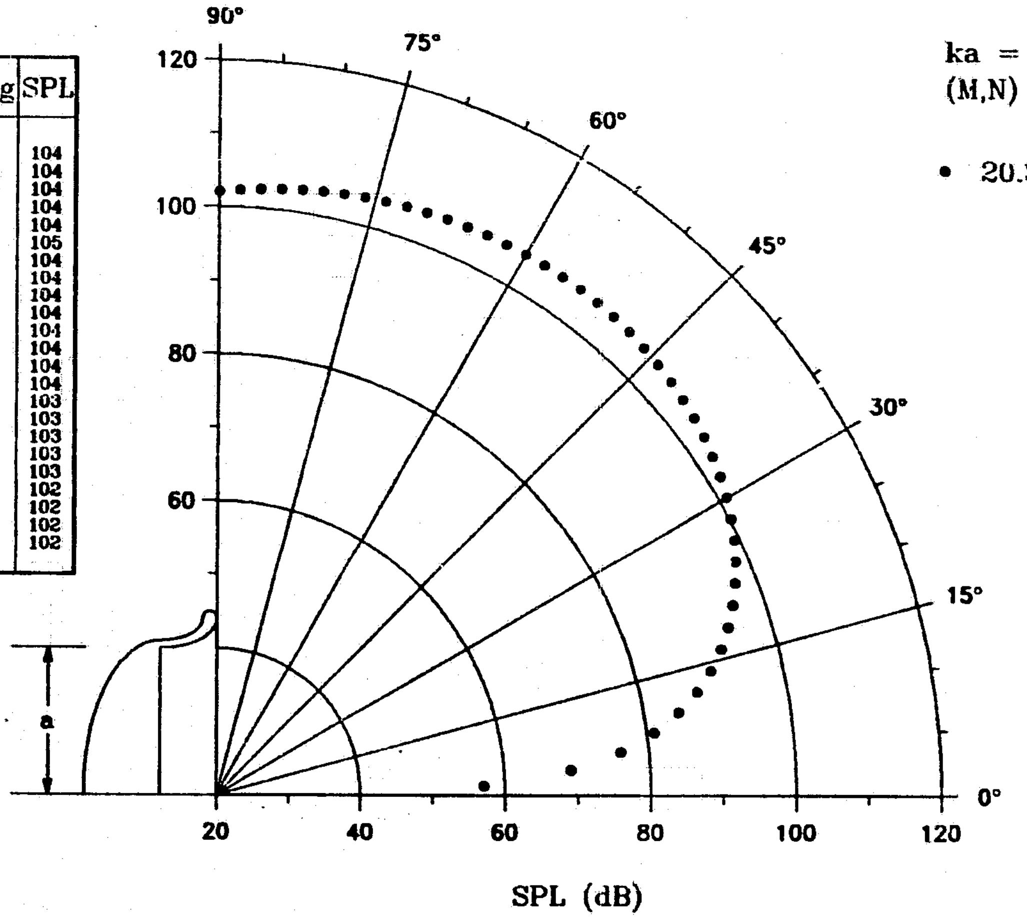
THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	104
2	57	48	104
4	69	50	104
6	76	52	104
8	80	54	104
10	84	56	105
12	87	58	104
14	90	60	104
16	92	62	104
18	94	64	104
20	95	66	104
22	97	68	104
24	98	70	104
26	99	72	104
28	100	74	103
30	101	76	103
32	101	78	103
34	102	80	103
36	102	82	103
38	103	84	102
40	103	86	102
42	104	88	102
44	104	90	102



ka = 3.07
(M,N) = (2,1)

• 20.33a

Fig. 42a

THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	[illegible]	46	104
2	57	48	105
4	69	50	105
6	76	52	105
8	81	54	105
10	85	56	105
12	88	58	105
14	90	60	105
16	93	62	105
18	[illegible]	64	105
20	96	66	104
22	97	68	104
24	98	70	104
26	99	72	104
28	100	74	104
30	101	76	104
32	102	78	103
34	102	80	103
36	103	82	103
38	103	84	103
40	104	86	102
42	104	88	102
44	104	90	102

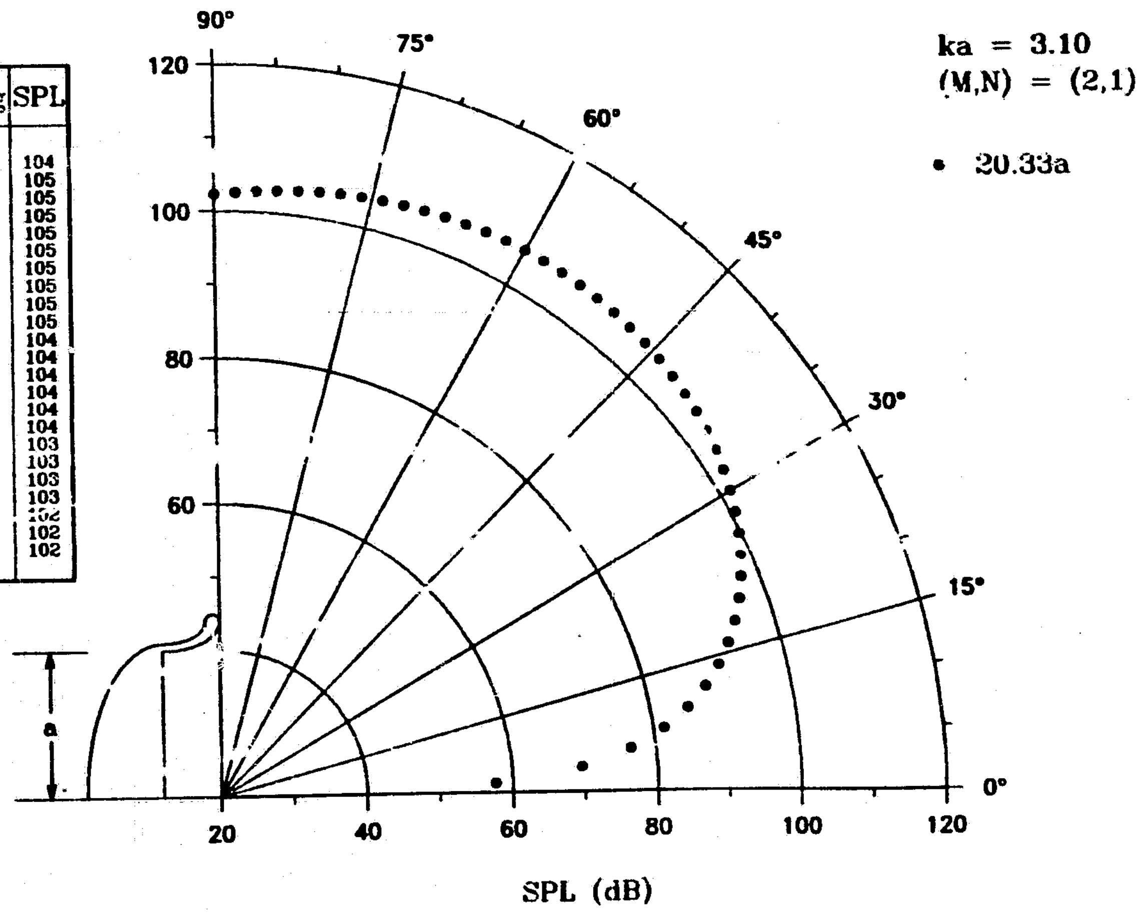


Fig. 42b

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THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	106
2	59	48	107
4	71	50	107
6	78	52	107
8	83	54	107
10	87	56	107
12	90	58	107
14	92	60	107
16	95	62	106
18	96	64	106
20	98	66	106
22	99	68	106
24	100	70	106
26	101	72	106
28	102	74	105
30	103	76	105
32	104	78	105
34	104	80	104
36	105	82	104
38	105	84	104
40	106	86	104
42	106	88	103
44	106	90	103

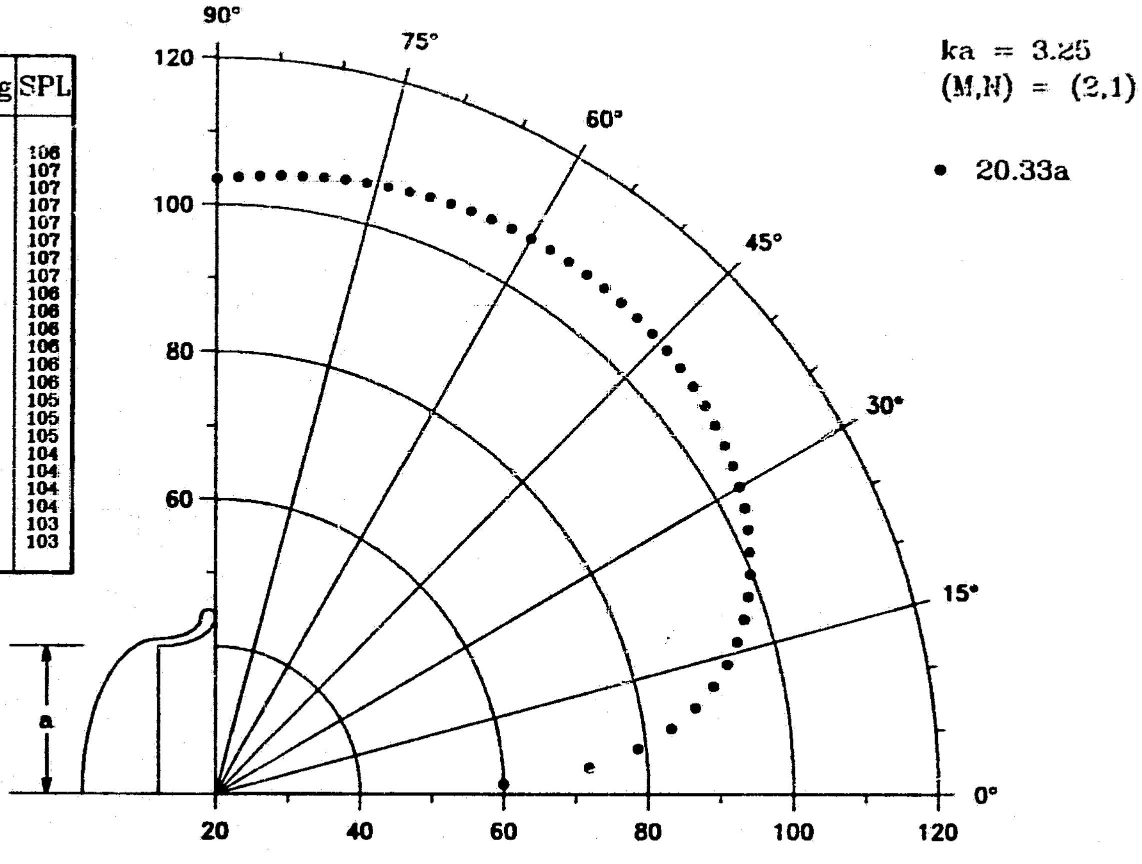

Fig. 42c

THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	110
2	64	48	110
4	76	50	110
6	83	52	110
8	87	54	110
10	91	56	110
12	94	58	110
14	97	60	109
16	99	62	109
18	100	64	109
20	102	66	109
22	103	68	109
24	104	70	108
26	105	72	108
28	106	74	108
30	107	76	108
32	108	78	107
34	108	80	107
36	108	82	107
38	109	84	106
40	109	86	106
42	109	88	106
44	110	90	105

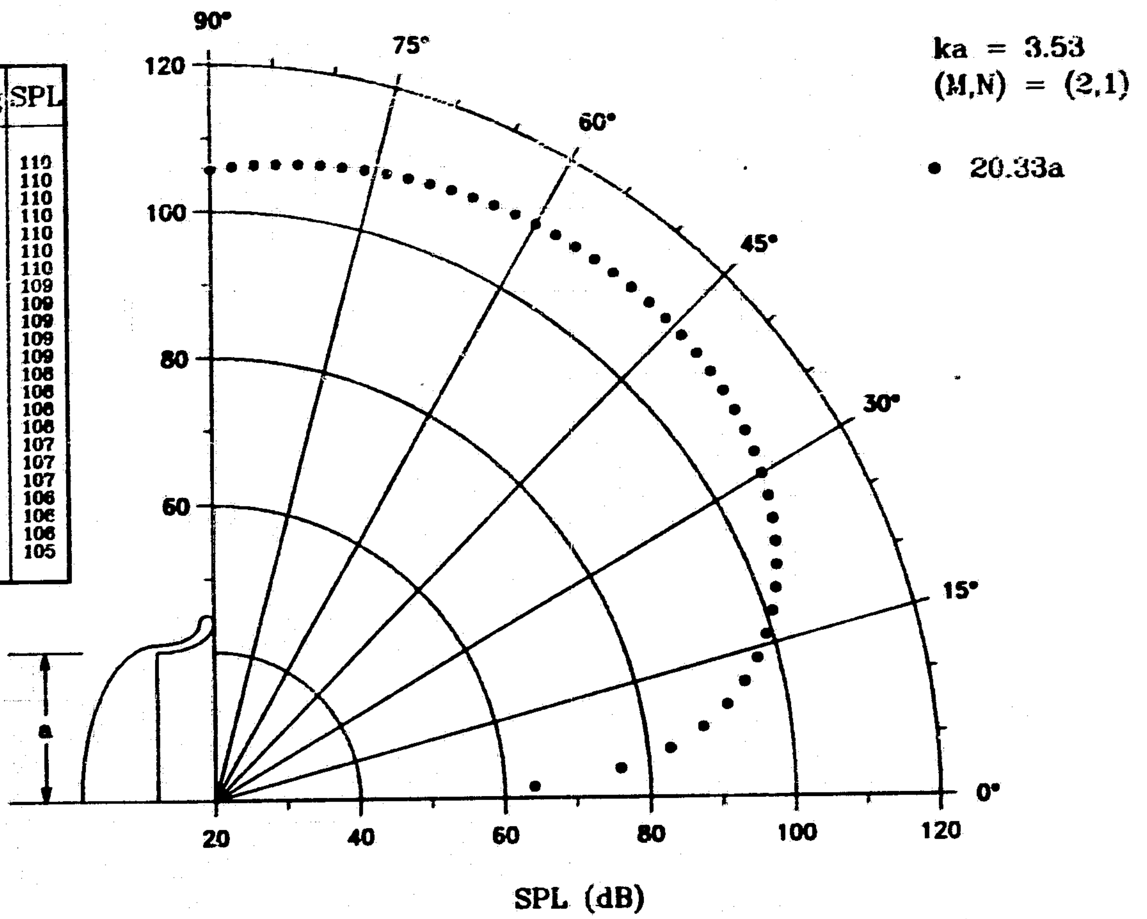

Fig. 42d

THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	115
2	70	48	115
4	82	50	115
6	89	52	114
8	94	54	114
10	98	56	114
12	101	58	114
14	103	60	113
16	105	62	113
18	107	64	113
20	108	66	113
22	109	68	112
24	110	70	112
26	111	72	112
28	112	74	111
30	113	76	111
32	113	78	110
34	114	80	110
36	114	82	110
38	114	84	109
40	115	86	109
42	115	88	109
44	115	90	108

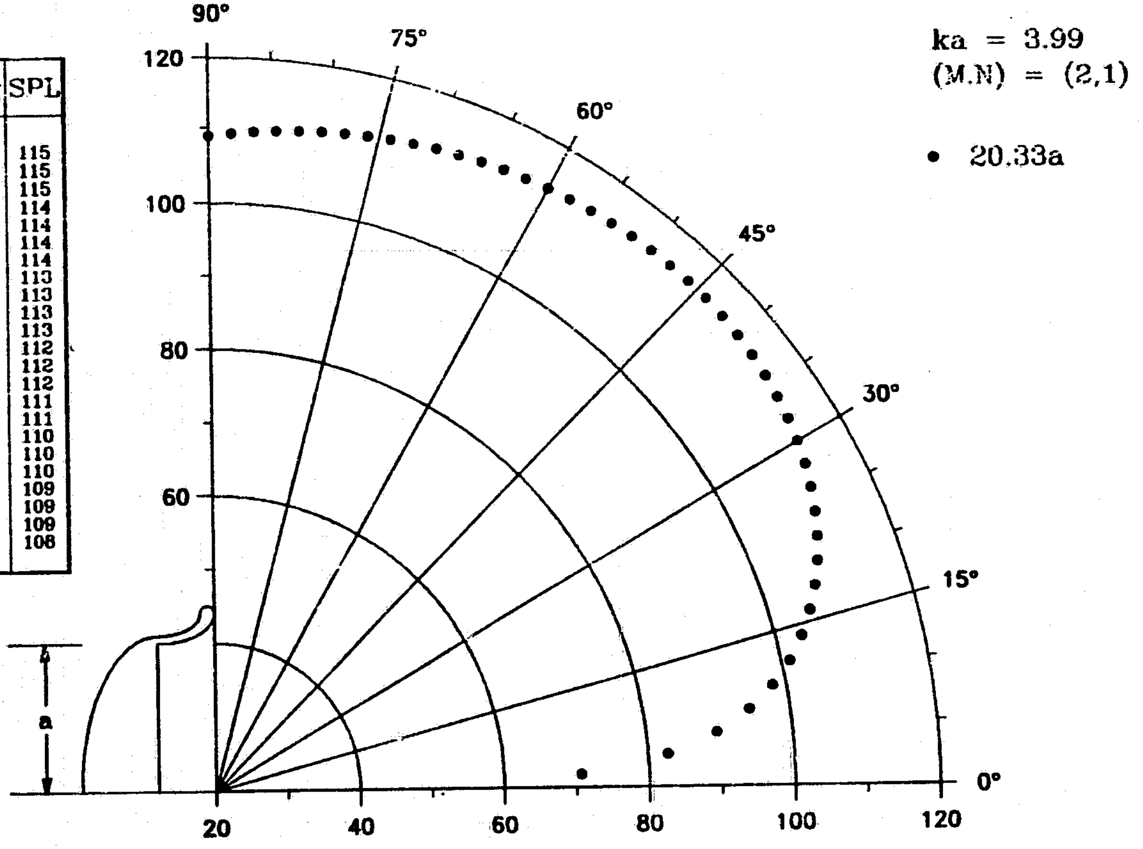

Fig. 42e

THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	120
2	78	48	120
4	90	50	120
6	97	52	119
8	102	54	119
10	106	56	118
12	108	58	118
14	111	60	117
16	113	62	117
18	114	64	116
20	116	66	116
22	117	68	115
24	118	70	114
26	119	72	114
28	119	74	113
30	120	76	112
32	120	78	112
34	120	80	111
36	121	82	111
38	121	84	110
40	121	86	110
42	121	88	110
44	120	90	109

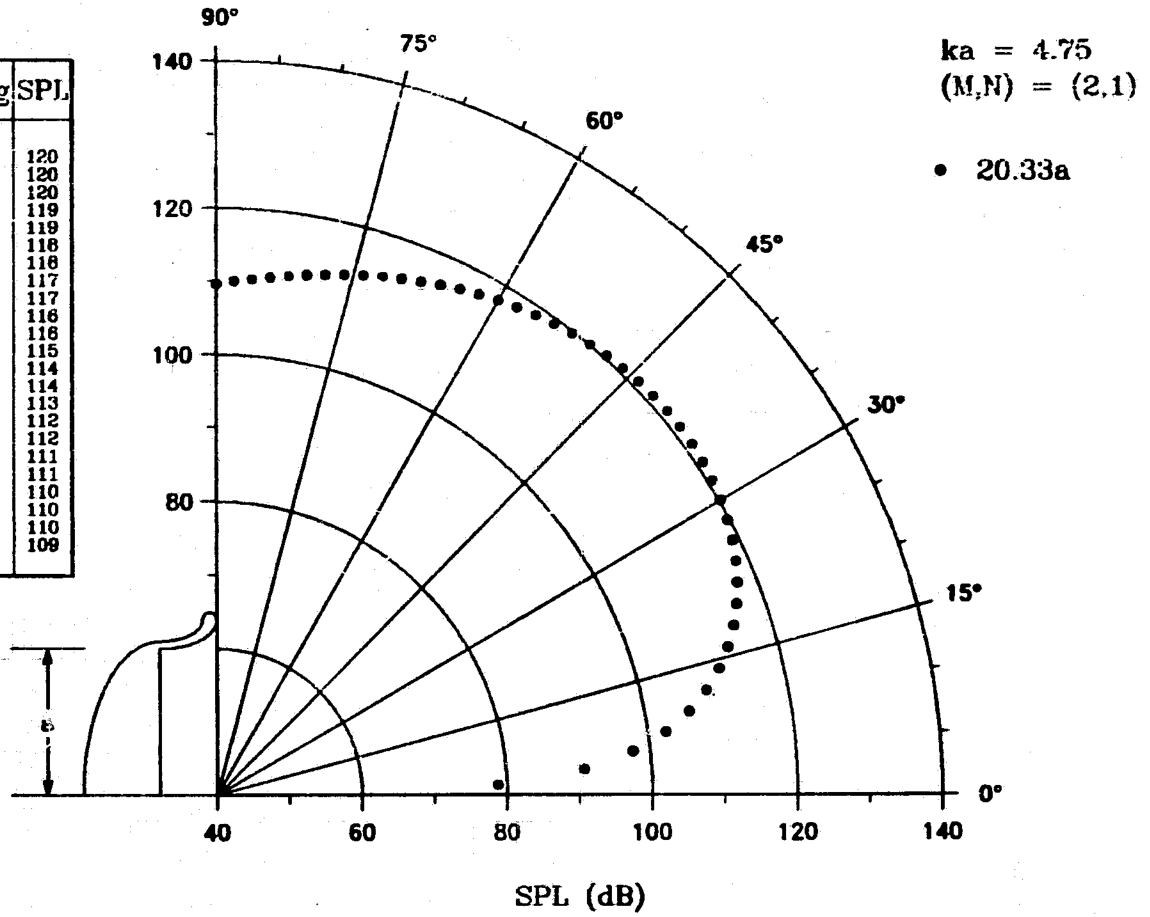

Fig. 42f

THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	122
2	82	48	122
4	94	50	121
6	101	52	120
8	106	54	120
10	109	56	119
12	112	58	119
14	114	60	118
16	116	62	117
18	118	64	116
20	119	66	116
22	120	68	115
24	121	70	114
26	122	72	113
28	122	74	112
30	123	76	112
32	123	78	111
34	123	80	110
36	123	82	109
38	123	84	109
40	123	86	108
42	123	88	108
44	122	90	107

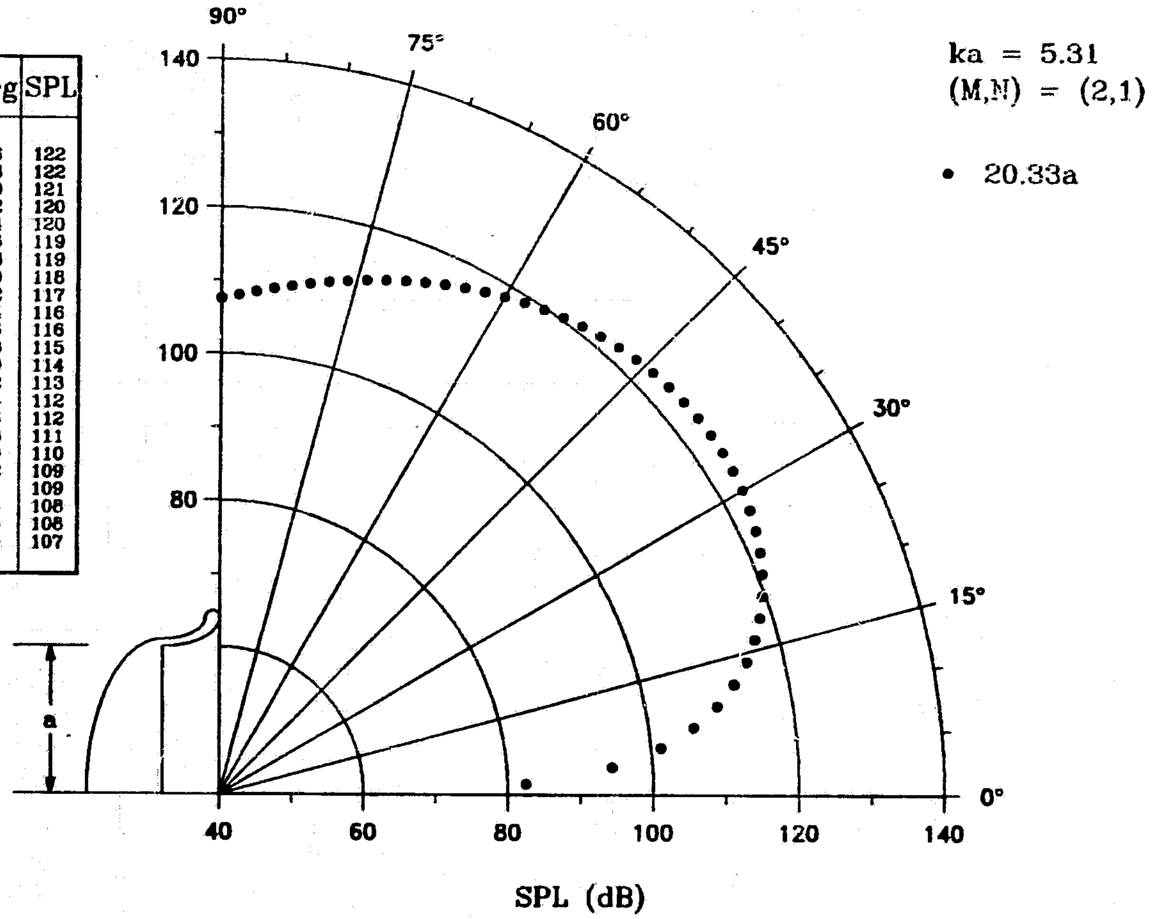

Fig. 42g

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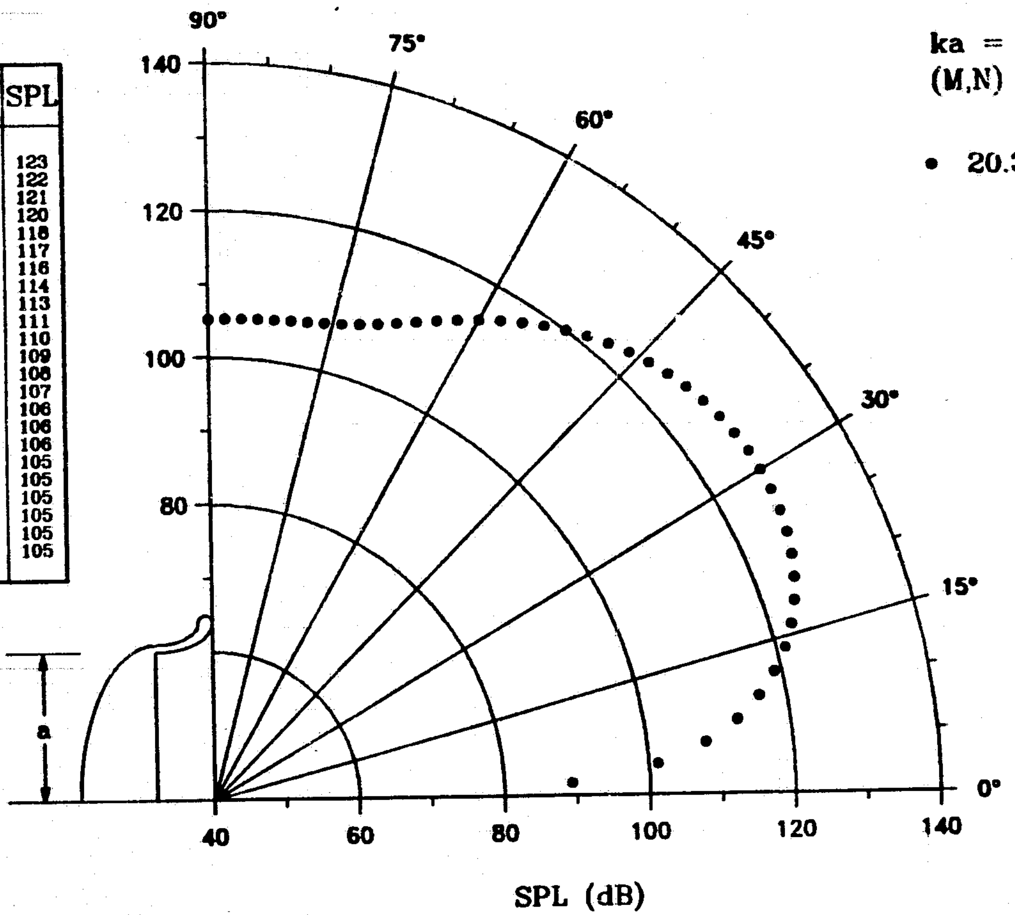
THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	123
2	89	48	122
4	101	50	121
6	108	52	120
8	112	54	118
10	116	56	117
12	119	58	116
14	121	60	114
16	122	62	113
18	124	64	111
20	125	66	110
22	126	68	109
24	126	70	108
26	127	72	107
28	127	74	106
30	127	76	106
32	127	78	106
34	127	80	105
36	126	82	105
38	126	84	105
40	125	86	105
42	125	88	105
44	124	90	105



ka = 6.57
(M,N) = (2,1)

• 20.33a

Fig. 42h

THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	106
2	10	48	106
4	34	50	107
6	48	52	107
8	58	54	107
10	66	56	107
12	72	58	107
14	77	60	107
16	81	62	107
18	84	64	107
20	88	66	107
22	90	68	107
24	93	70	107
26	95	72	106
28	97	74	106
30	98	76	106
32	100	78	106
34	101	80	105
36	102	82	105
38	103	84	105
40	104	86	104
42	105	88	104
44	105	90	104

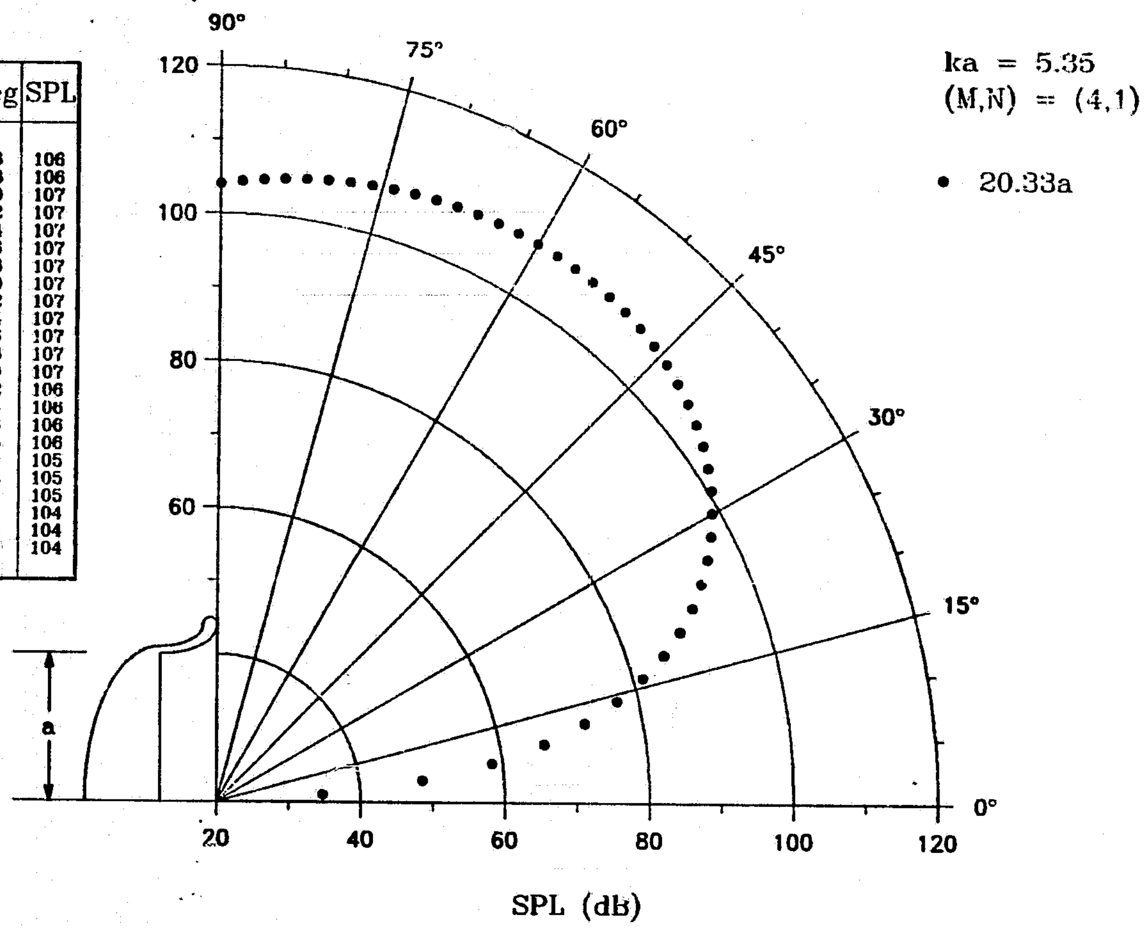
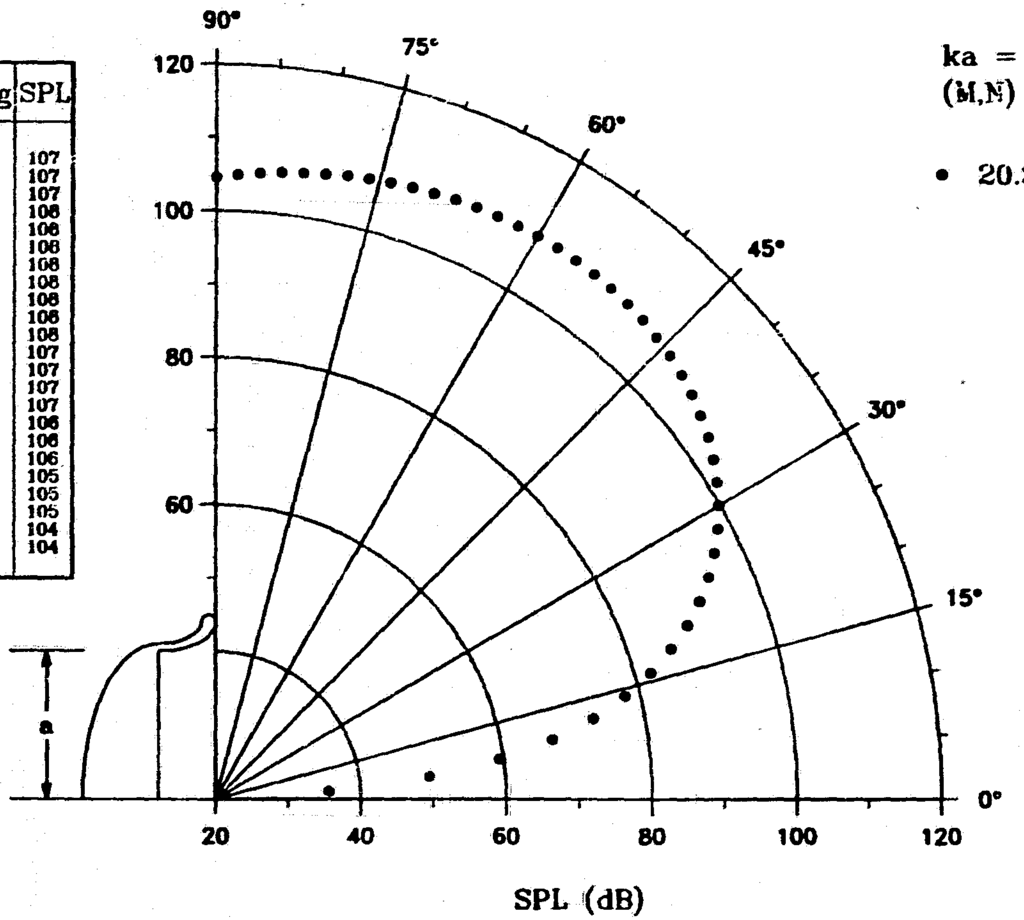


Fig. 43a

THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	107
2	11	48	107
4	35	50	107
6	49	52	108
8	59	54	108
10	66	56	108
12	72	58	108
14	77	60	108
16	82	62	108
18	85	64	108
20	88	66	108
22	91	68	107
24	94	70	107
26	96	72	107
28	98	74	107
30	99	76	106
32	101	78	106
34	102	80	106
36	103	82	105
38	104	84	105
40	105	86	105
42	106	88	104
44	106	90	104



ka = 5.40
(M,N) = (4,1)

• 20.33a

Fig. 43b

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THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	110
2	15	48	110
4	39	50	111
6	53	52	111
8	63	54	111
10	71	56	111
12	77	58	111
14	82	60	111
16	86	62	111
18	89	64	110
20	93	66	110
22	95	68	110
24	98	70	110
26	100	72	109
28	102	74	109
30	103	76	109
32	105	78	108
34	106	80	108
36	107	82	108
38	108	84	107
40	109	86	107
42	109	88	107
44	110	90	106

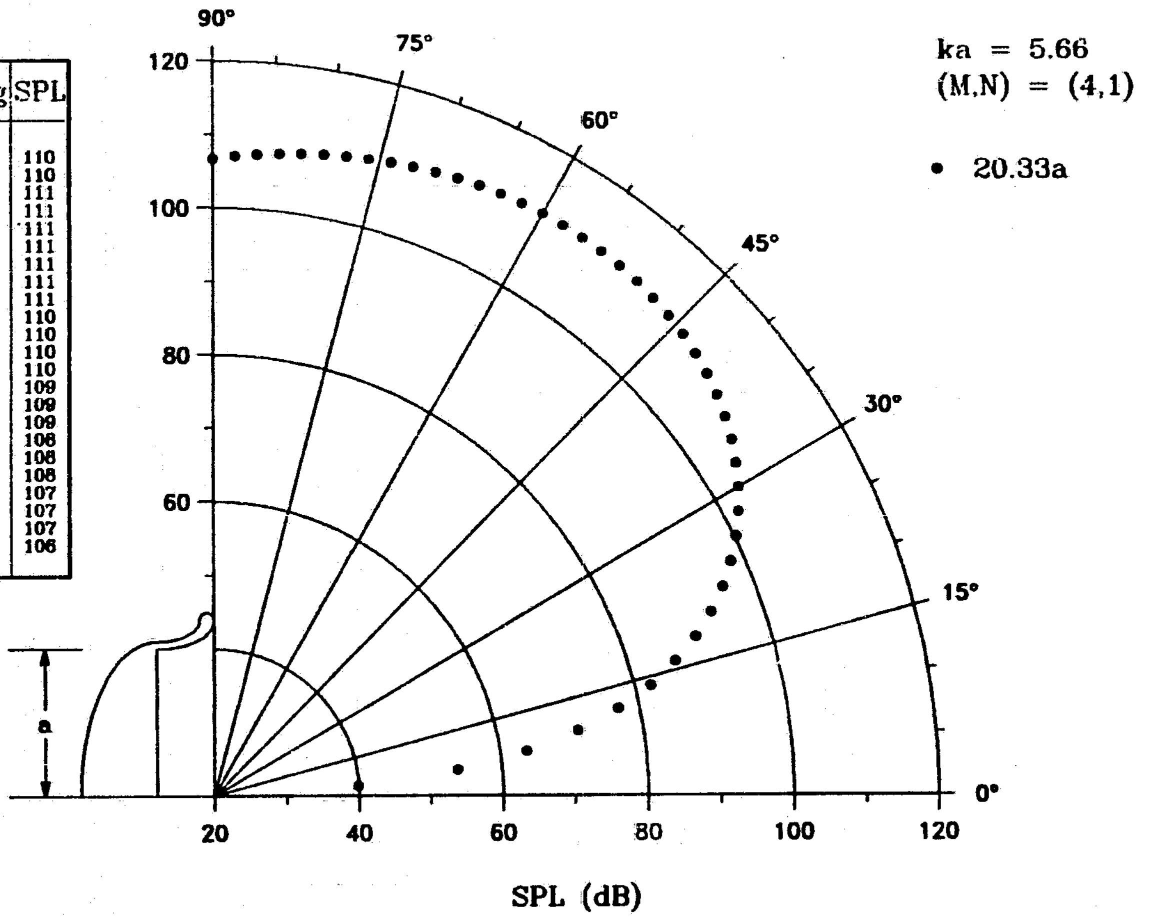

Fig. 43c

THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	116
2	22	48	116
4	46	50	116
6	60	52	116
8	70	54	116
10	77	56	116
12	83	58	115
14	88	60	115
16	92	62	115
18	96	64	115
20	99	66	114
22	102	68	114
24	104	70	113
26	106	72	113
28	108	74	112
30	109	76	112
32	111	78	111
34	112	80	111
36	113	82	110
38	114	84	110
40	114	86	110
42	115	88	109
44	115	90	109

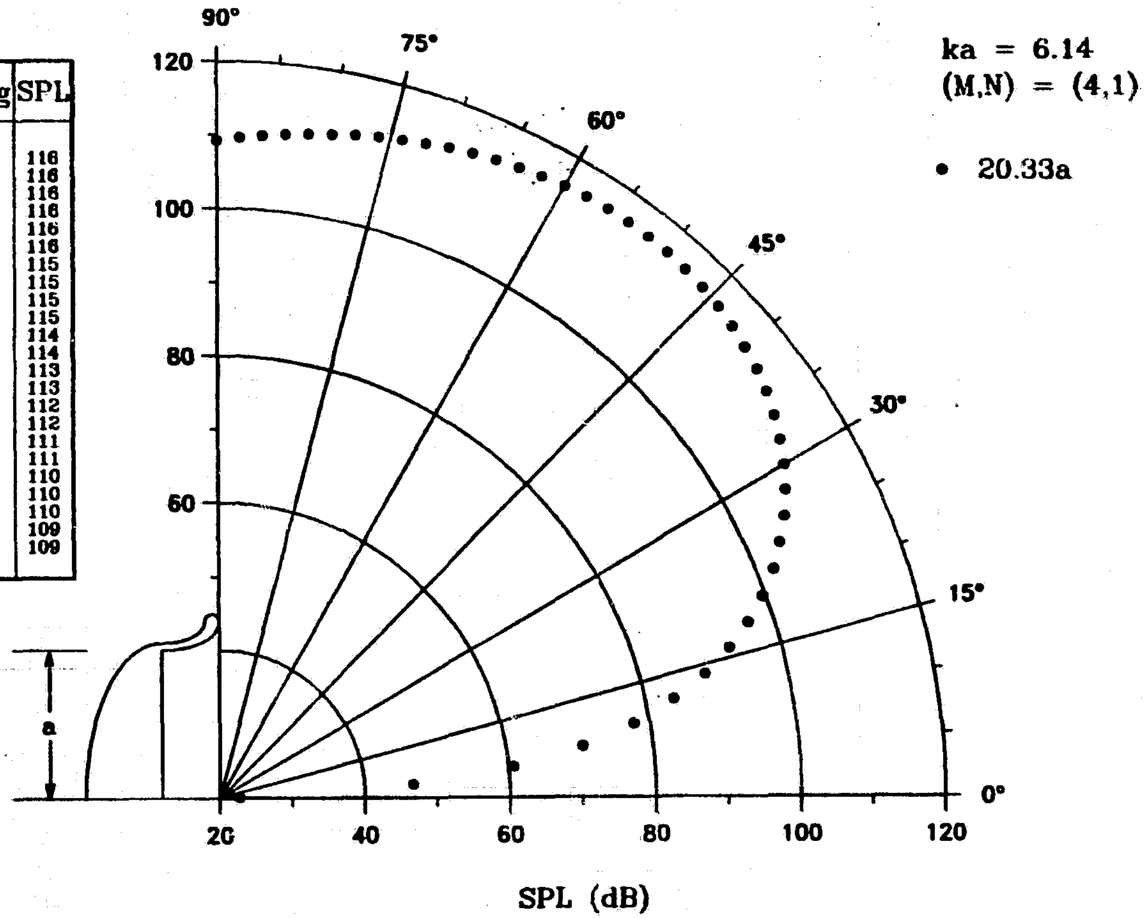

Fig. 43d

THICK LIPPED ELLIPTICAL INLET

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Deg	SPL	Deg	SPL
0	0	46	120
2	29	48	120
4	53	50	120
6	67	52	120
8	77	54	120
10	84	56	120
12	90	58	119
14	95	60	119
16	99	62	118
18	103	64	118
20	106	66	117
22	108	68	116
24	111	70	116
26	112	72	115
28	114	74	114
30	116	76	114
32	117	78	113
34	118	80	112
36	118	82	111
38	119	84	111
40	120	86	110
42	120	88	109
44	120	90	109

ka = 6.94
(M,N) = (4,1)

• 20.33a

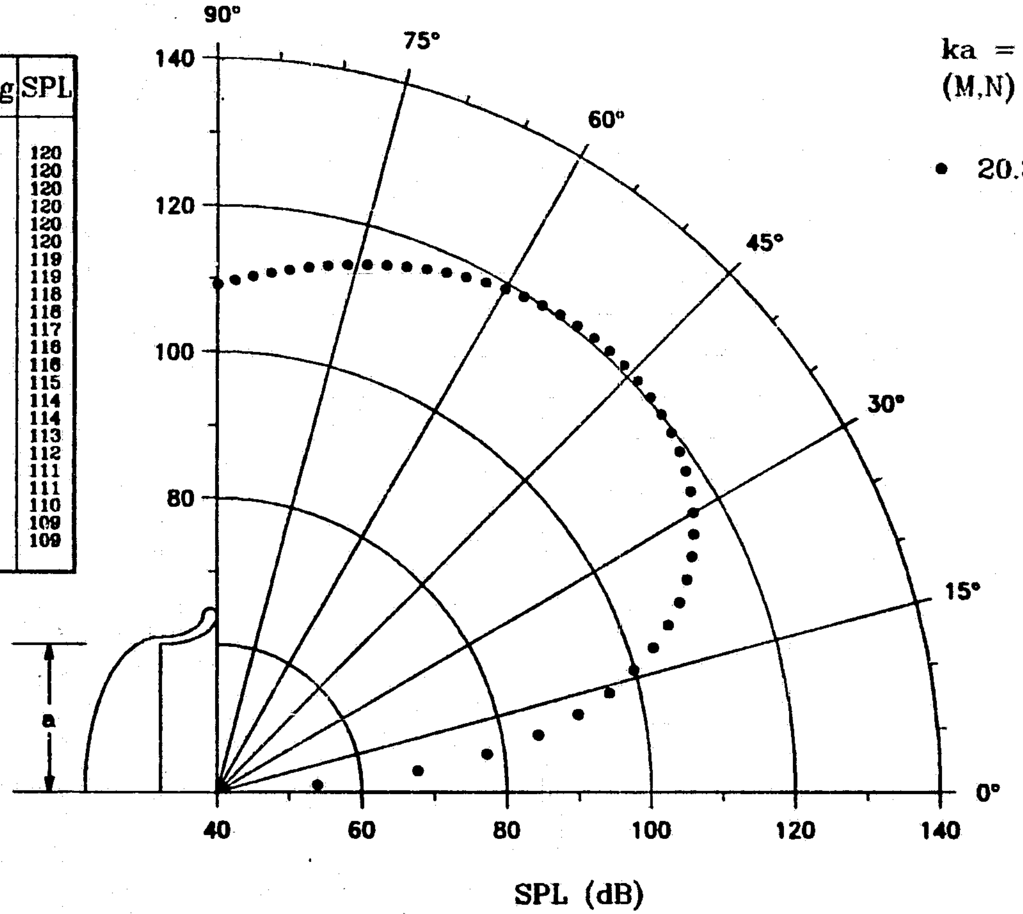
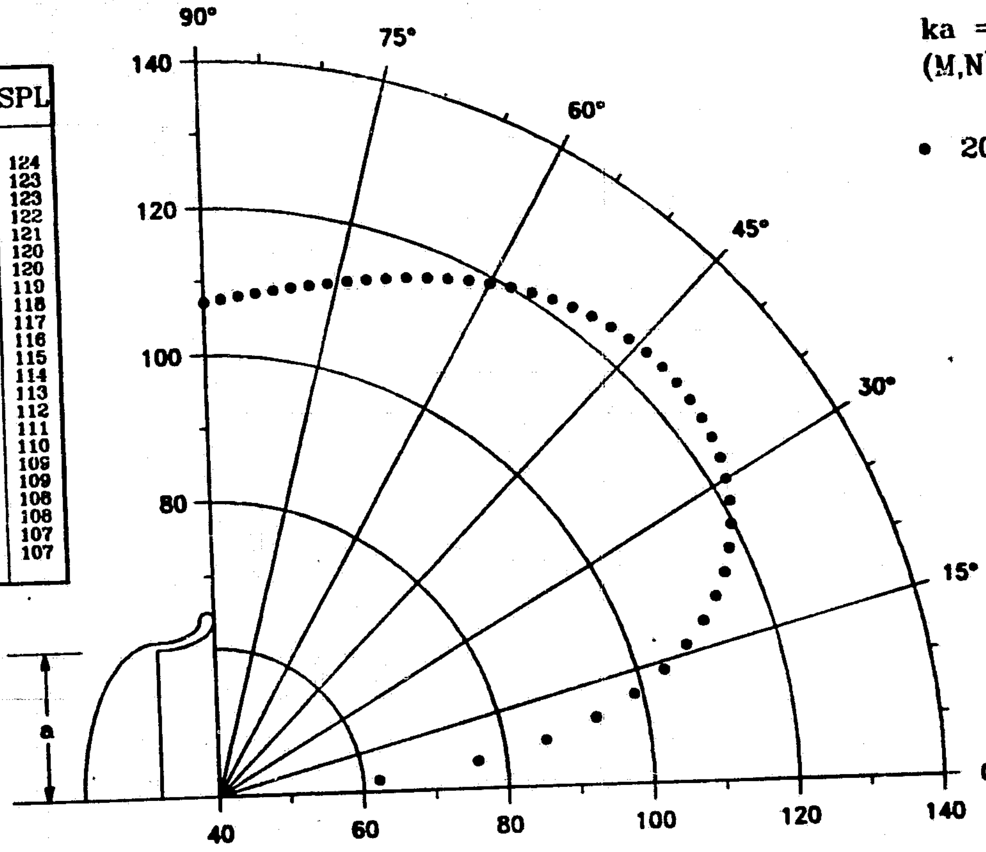


Fig. 43e

THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	124
2	38	48	123
4	62	50	123
6	76	52	122
8	85	54	121
10	93	56	120
12	98	58	120
14	103	60	119
16	107	62	118
18	110	64	117
20	113	66	116
22	116	68	115
24	117	70	114
26	119	72	113
28	121	74	112
30	122	76	111
32	123	78	110
34	123	80	109
36	124	82	109
38	124	84	108
40	124	86	108
42	124	88	107
44	124	90	107



$ka = 8.28$
$(M,N) = (4,1)$

• 20.33a

Fig. 43f

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THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	108
2	-85	48	109
4	-37	50	110
6	-9	52	110
8	10	54	111
10	25	56	111
12	37	58	111
14	47	60	111
16	56	62	111
18	63	64	111
20	69	66	111
22	75	68	111
24	80	70	111
26	84	72	110
28	88	74	110
30	92	76	109
32	95	78	109
34	97	80	108
36	100	82	108
38	102	84	107
40	104	86	107
42	105	88	106
44	107	90	106

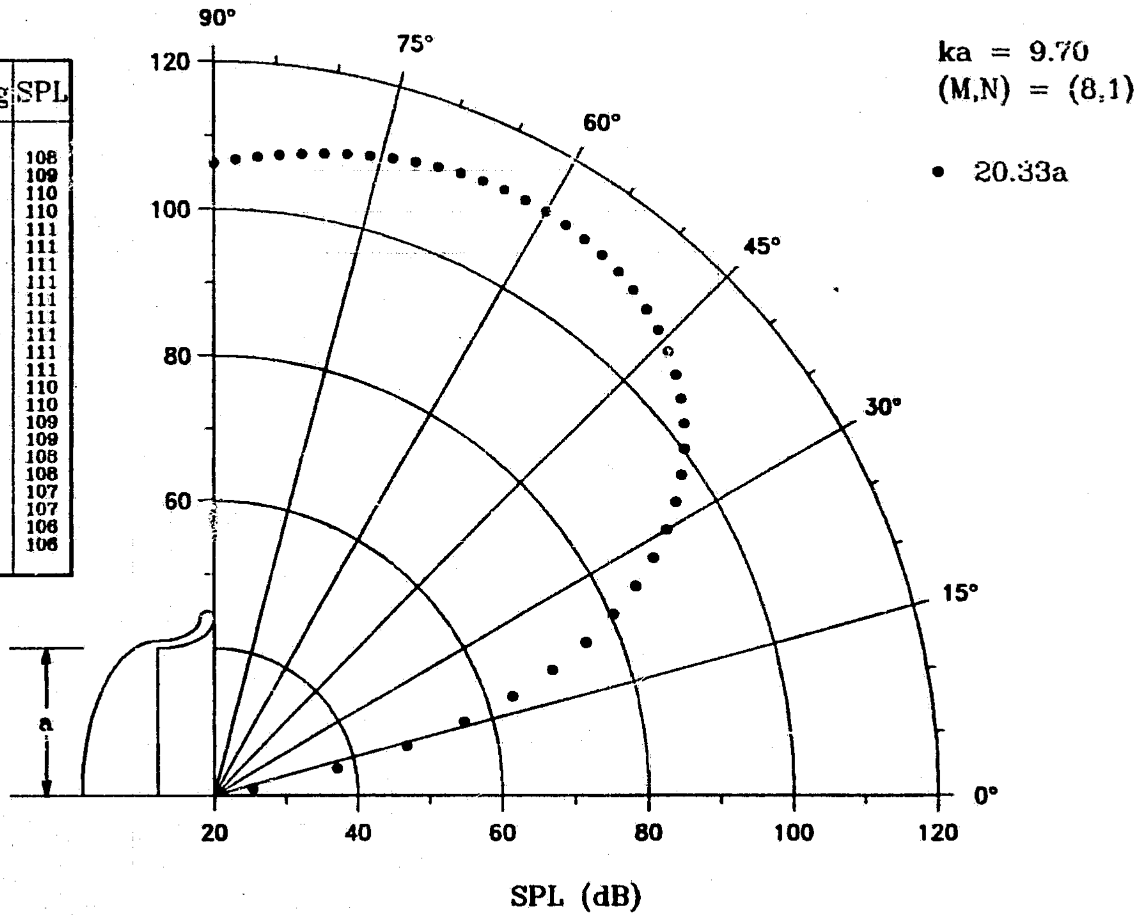

Fig. 44a

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THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	109
2	−83	48	110
4	−35	50	111
6	−7	52	111
8	11	54	112
10	26	56	112
12	36	58	112
14	48	60	112
16	57	62	112
18	64	64	112
20	71	66	112
22	76	68	112
24	81	70	112
26	86	72	111
28	89	74	111
30	93	76	110
32	96	78	110
34	99	80	109
36	101	82	109
38	103	84	108
40	105	86	107
42	106	88	107
44	108	90	106

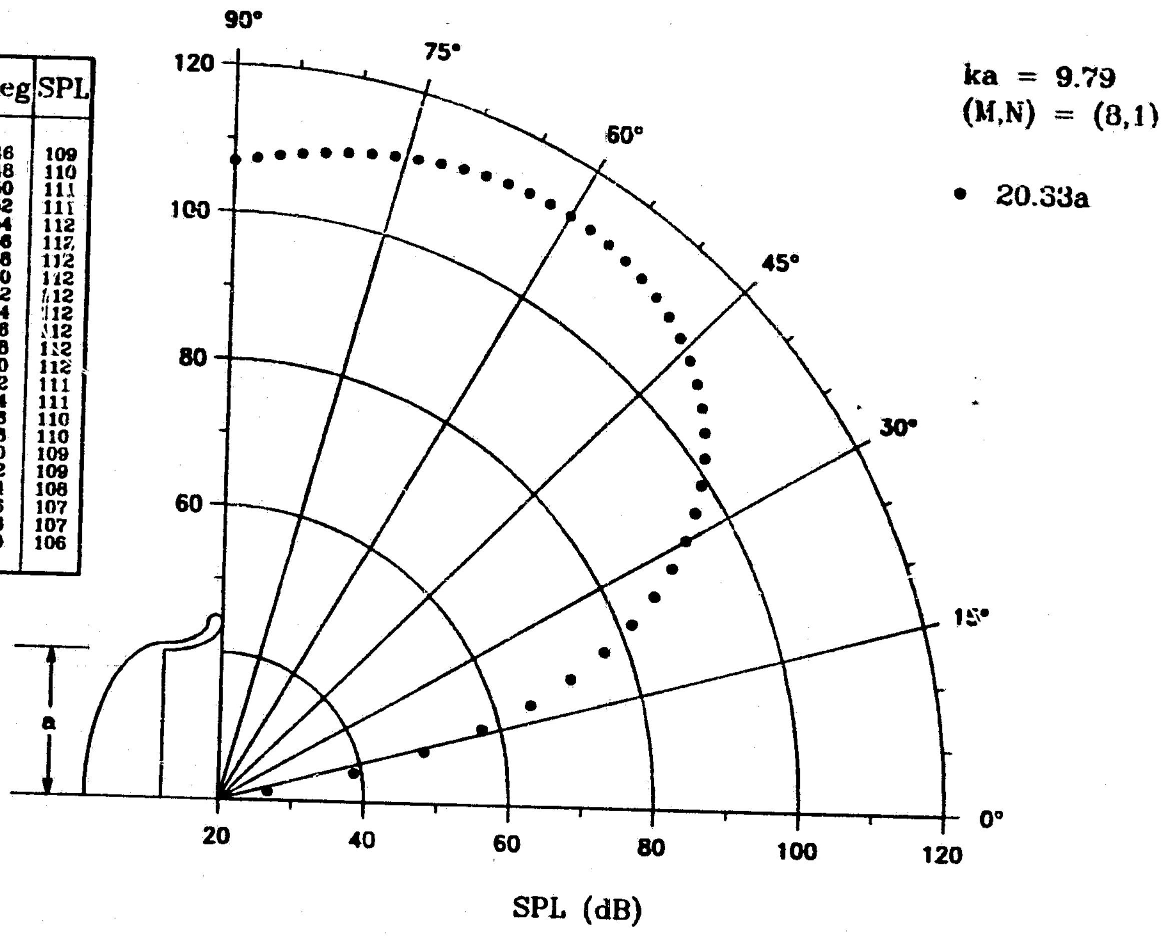
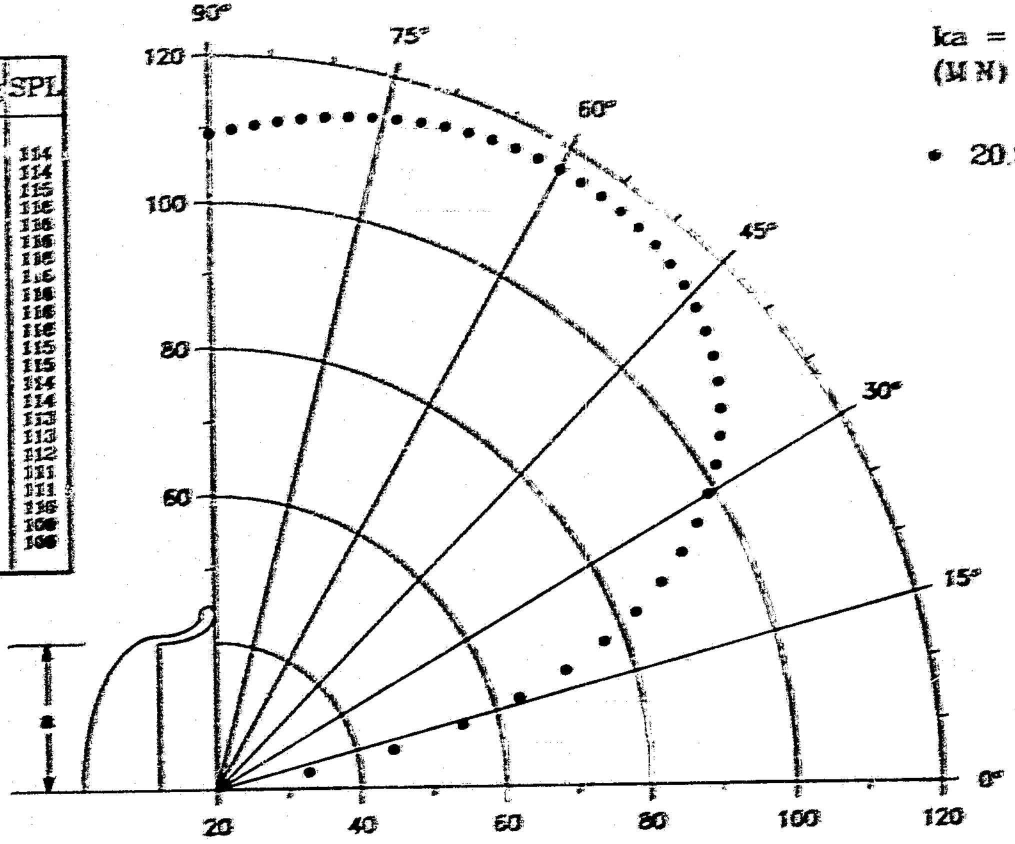


Fig. 44b

THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	6	46	114
2	-77	48	114
4	-23	50	115
6	-1	52	116
8	17	54	116
10	32	56	116
12	44	58	116
14	54	60	116
16	63	62	116
18	70	64	116
20	77	66	116
22	82	68	115
24	87	70	115
26	91	72	114
28	95	74	114
30	98	76	113
32	101	78	113
34	104	80	112
36	106	82	111
38	108	84	111
40	110	86	110
42	111	88	108
44	113	90	106



SPL (dB)

ka = 10.26
(M N) = (8,1)

• 20.33a

Fig. 44c

THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	119
2	−69	48	119
4	−21	50	120
6	6	52	120
8	25	54	120
10	40	56	120
12	52	58	120
14	62	60	120
16	71	62	119
18	78	64	119
20	84	66	118
22	89	68	118
24	94	70	117
26	98	72	116
28	102	74	116
30	105	76	115
32	108	78	114
34	110	80	114
36	112	82	113
38	114	84	112
40	116	86	111
42	117	88	111
44	118	90	110

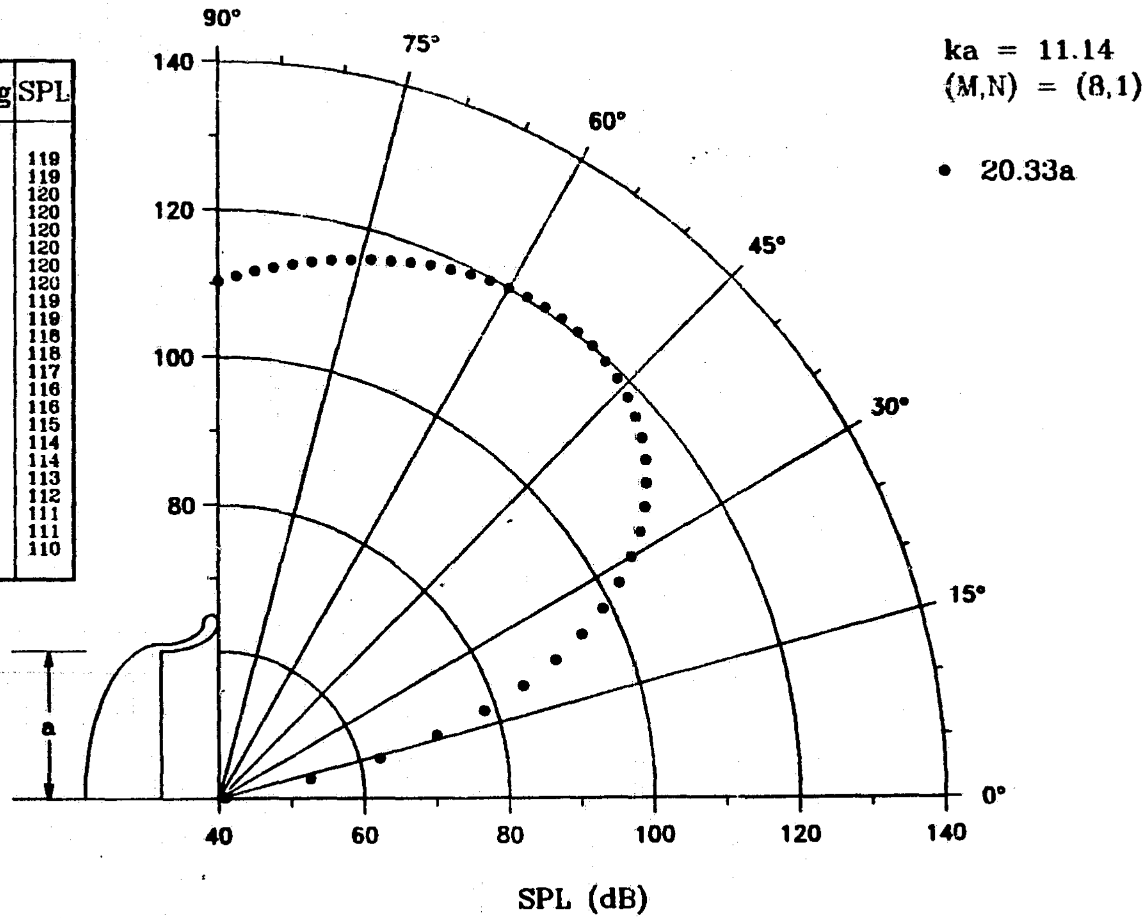
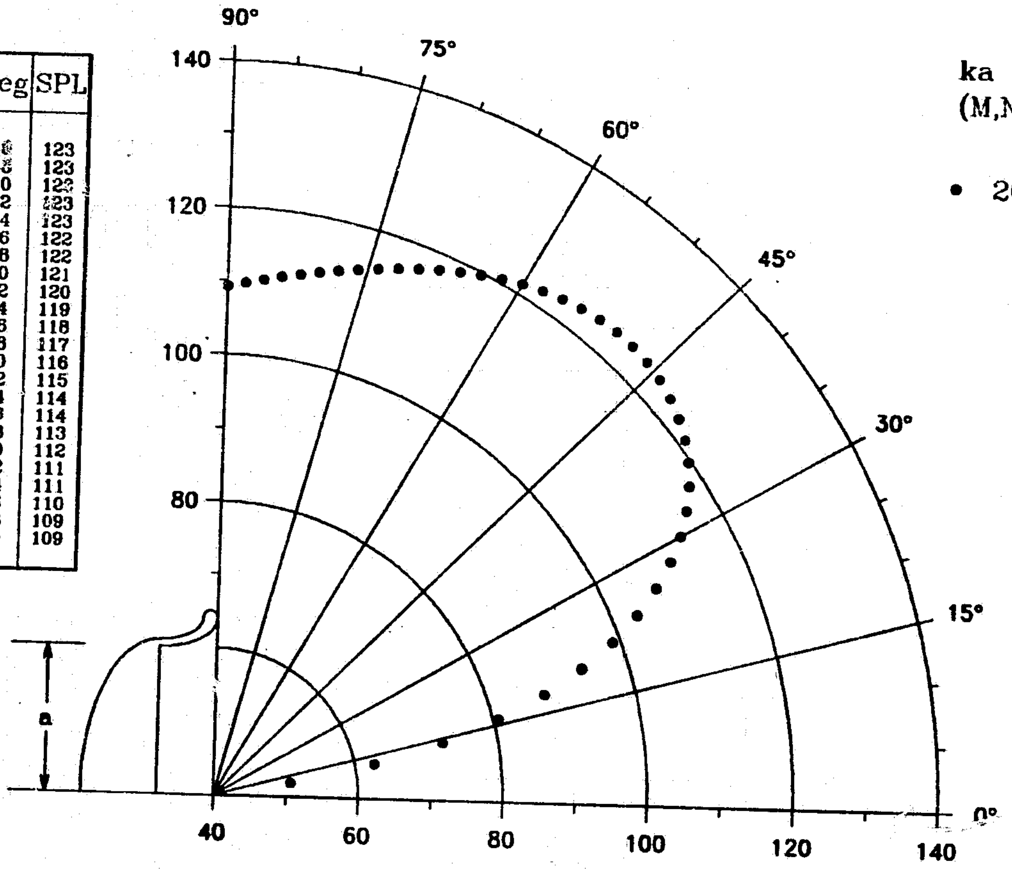


Fig. 44d

THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	123
2	-59	48	123
4	-11	50	123
6	16	52	123
8	35	54	123
10	50	56	122
12	62	58	122
14	72	60	121
16	80	62	120
18	87	64	119
20	93	66	118
22	98	68	117
24	103	70	116
26	107	72	115
28	110	74	114
30	113	76	114
32	115	78	113
34	117	80	112
36	119	82	111
38	121	84	111
40	122	86	110
42	122	88	109
44	123	90	109



ka = 12.59
(M,N) = (8,1)

• 20.33a

Fig. 44e

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THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	127
2	-45	48	128
4	2	50	125
6	29	52	124
8	49	54	123
10	64	56	121
12	75	58	119
14	85	60	118
16	93	62	116
18	99	64	115
20	105	66	113
22	110	68	112
24	114	70	111
26	117	72	110
28	120	74	110
30	122	76	109
32	124	78	109
34	126	80	108
36	127	82	108
38	127	84	108
40	128	86	107
42	128	88	107
44	127	90	106

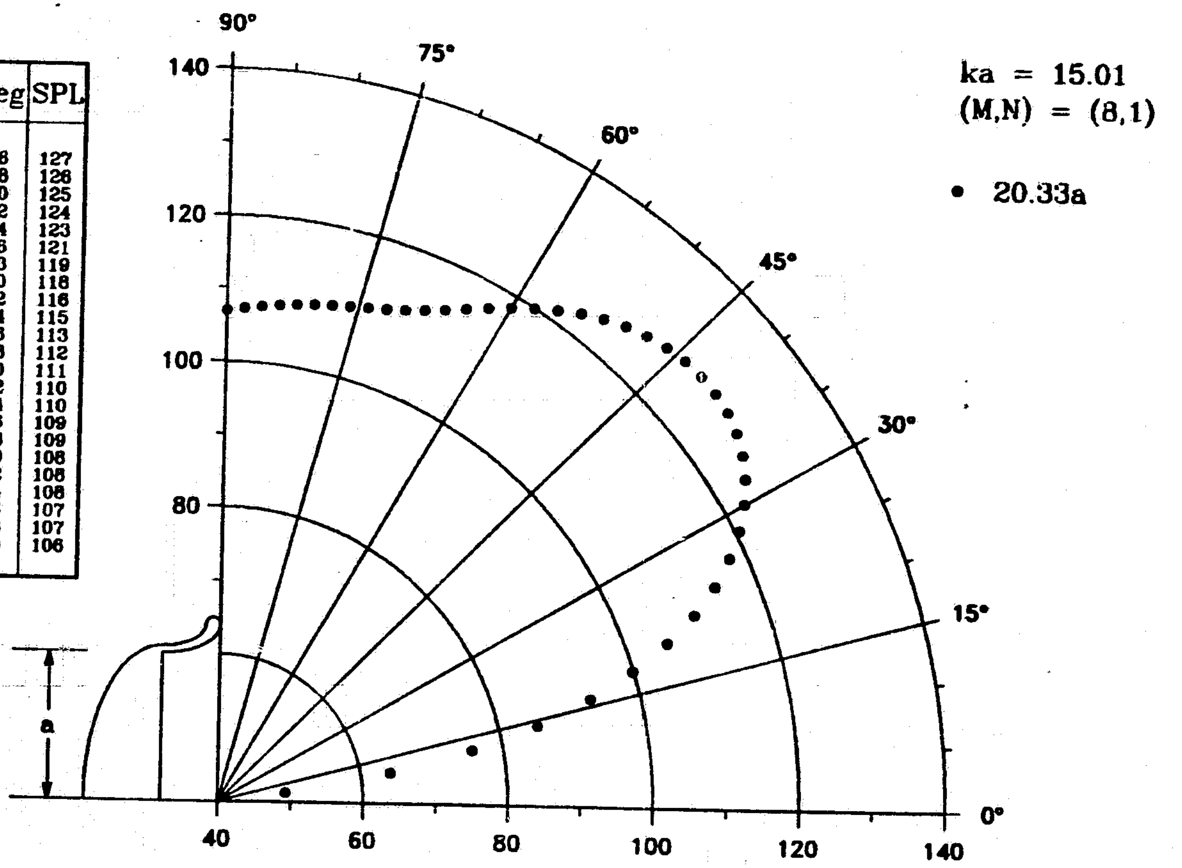

Fig. 44f

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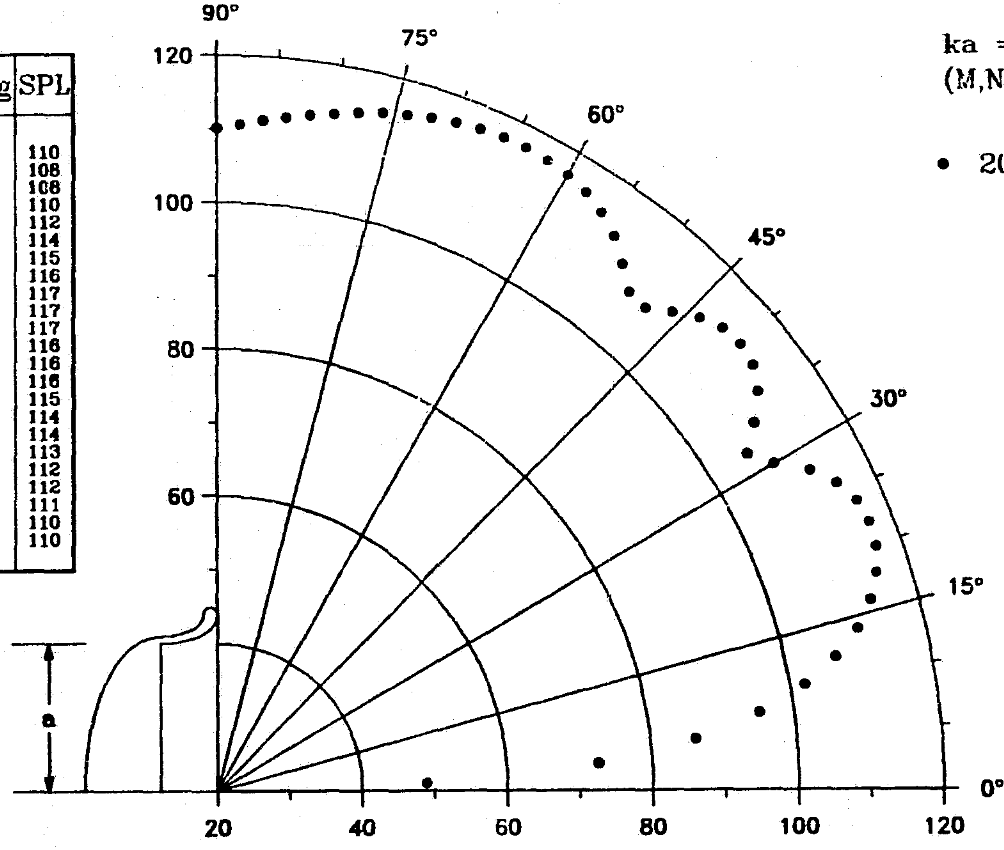
THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	110
2	48	48	108
4	72	50	108
6	86	52	110
8	95	54	112
10	101	56	114
12	106	58	115
14	110	60	116
16	113	62	117
18	115	64	117
20	116	66	117
22	116	68	116
24	116	70	116
26	114	72	116
28	112	74	115
30	108	76	114
32	105	78	114
34	109	80	113
36	111	82	112
38	113	84	112
40	113	86	111
42	113	88	110
44	112	90	110



ka = 12.74
(M,N) = (4.3)

• 20.33a

Fig. 45a

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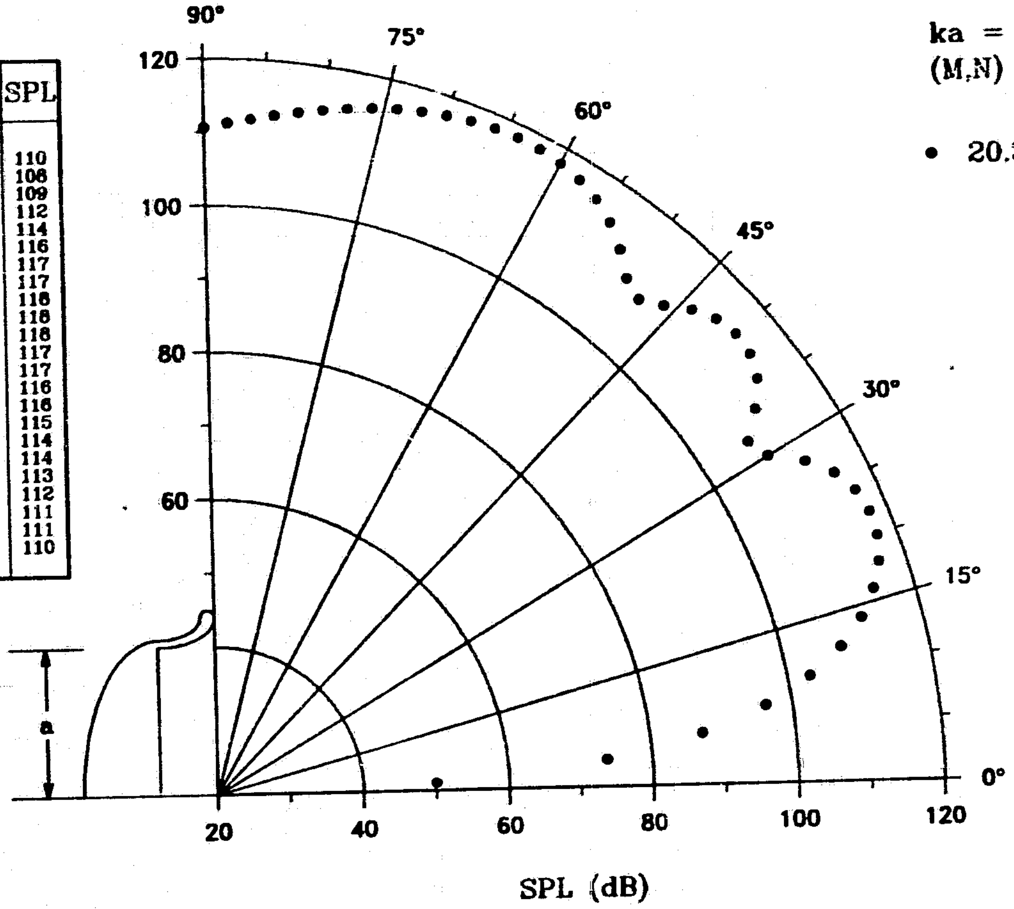
THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	110
2	50	48	108
4	73	50	109
6	87	52	112
8	96	54	114
10	103	56	116
12	108	58	117
14	111	60	117
16	114	62	118
18	116	64	118
20	117	66	118
22	117	68	117
24	116	70	117
26	115	72	116
28	112	74	116
30	108	76	115
32	107	78	114
34	110	80	114
36	113	82	113
38	114	84	112
40	114	86	111
42	114	88	111
44	112	90	110



ka = 12.87
(M,N) = (4,3)

• 20.33a

Fig. 45b

THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	111
2	54	48	114
4	77	50	117
6	91	52	119
8	100	54	120
10	106	56	121
12	111	58	121
14	115	60	122
16	117	62	121
18	119	64	121
20	120	66	121
22	119	68	120
24	118	70	119
26	116	72	119
28	112	74	118
30	110	76	117
32	113	78	116
34	116	80	115
36	117	82	114
38	117	84	114
40	117	86	113
42	115	88	112
44	112	90	111

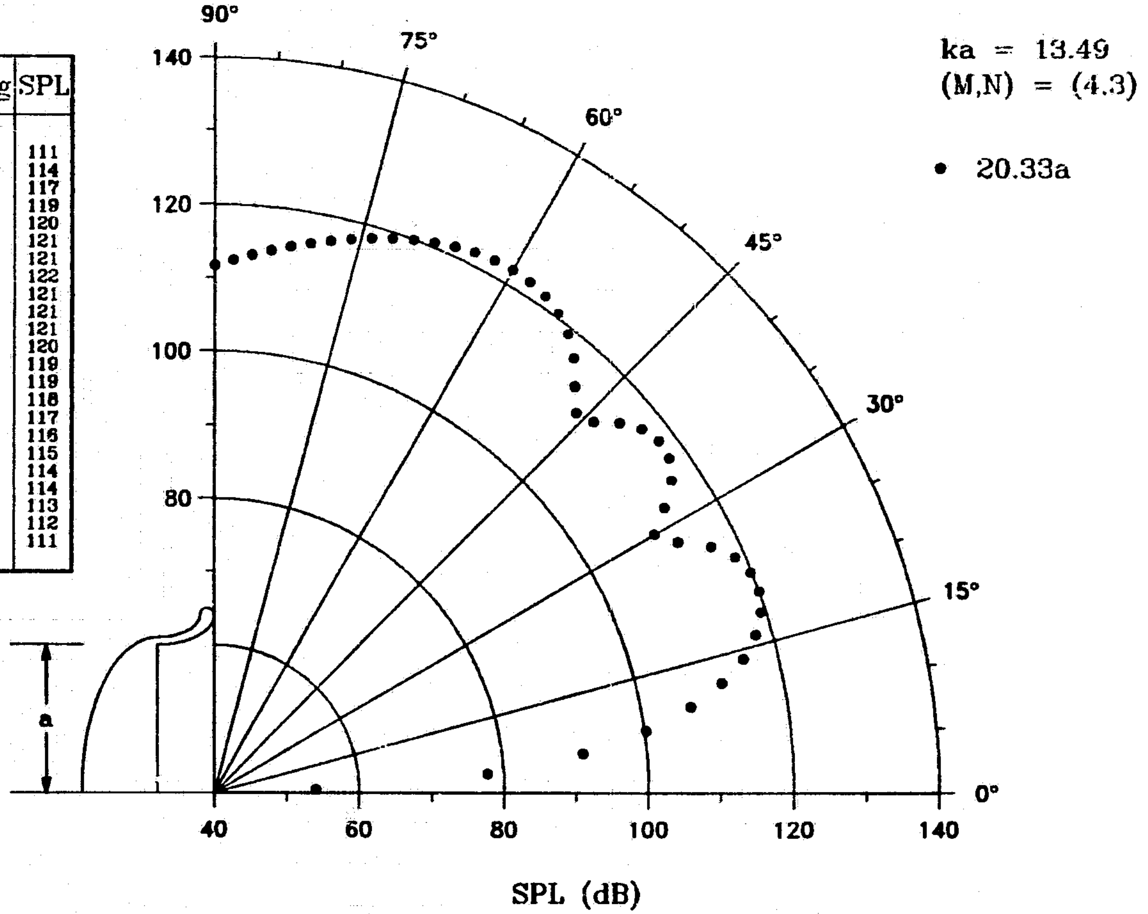


Fig. 45c

THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	121
2	58	48	123
4	82	50	124
6	95	52	125
8	104	54	125
10	110	56	125
12	115	58	125
14	118	60	125
16	120	62	124
18	121	64	123
20	121	66	122
22	120	68	121
24	117	70	120
26	114	72	119
28	113	74	118
30	117	76	117
32	119	78	116
34	120	80	115
36	119	82	114
38	117	84	113
40	115	86	112
42	115	88	111
44	118	90	111

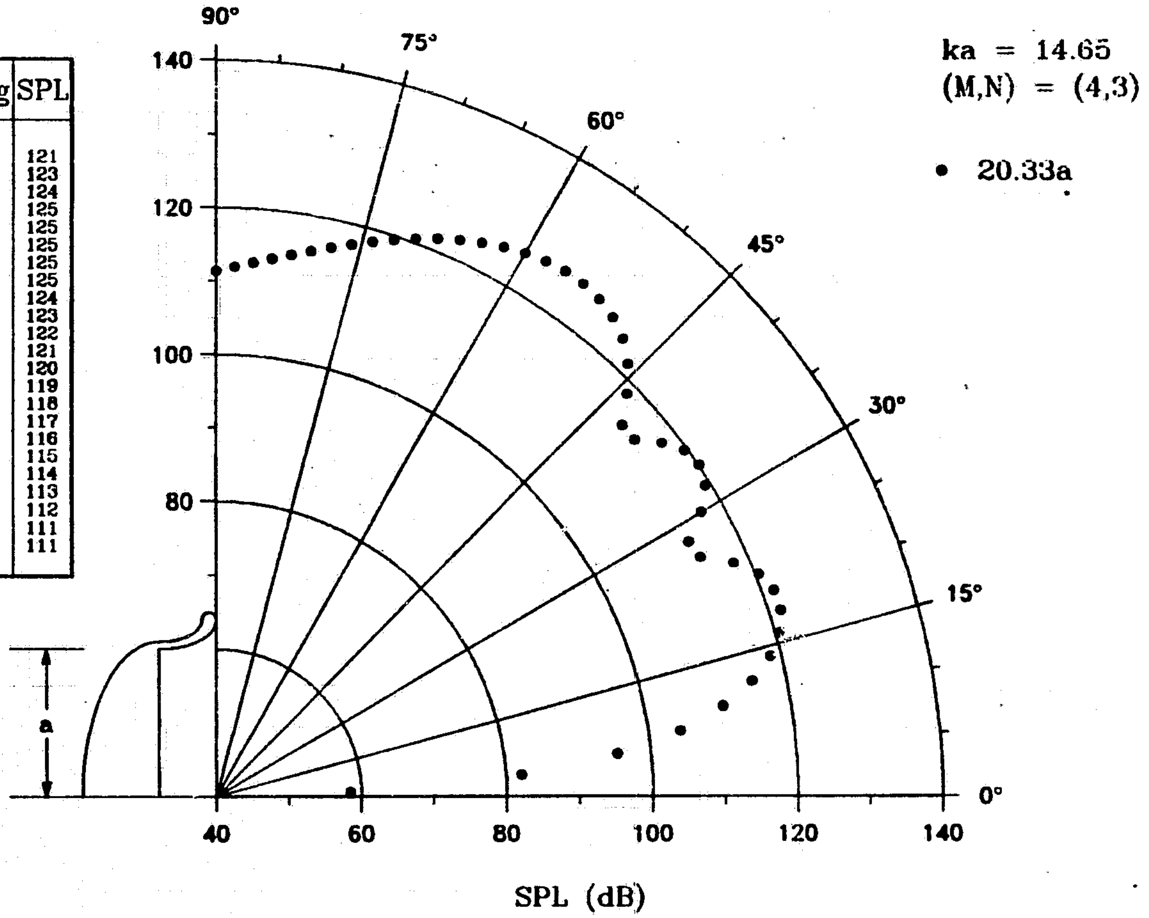


Fig. 45d

THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	129
2	63	48	129
4	86	50	129
6	99	52	129
8	108	54	128
10	114	56	127
12	118	58	125
14	121	60	124
16	122	62	122
18	122	64	120
20	120	66	118
22	116	68	116
24	114	70	115
26	118	72	113
28	120	74	112
30	121	76	111
32	120	78	110
34	117	80	109
36	116	82	108
38	121	84	108
40	124	86	108
42	127	88	107
44	128	90	107

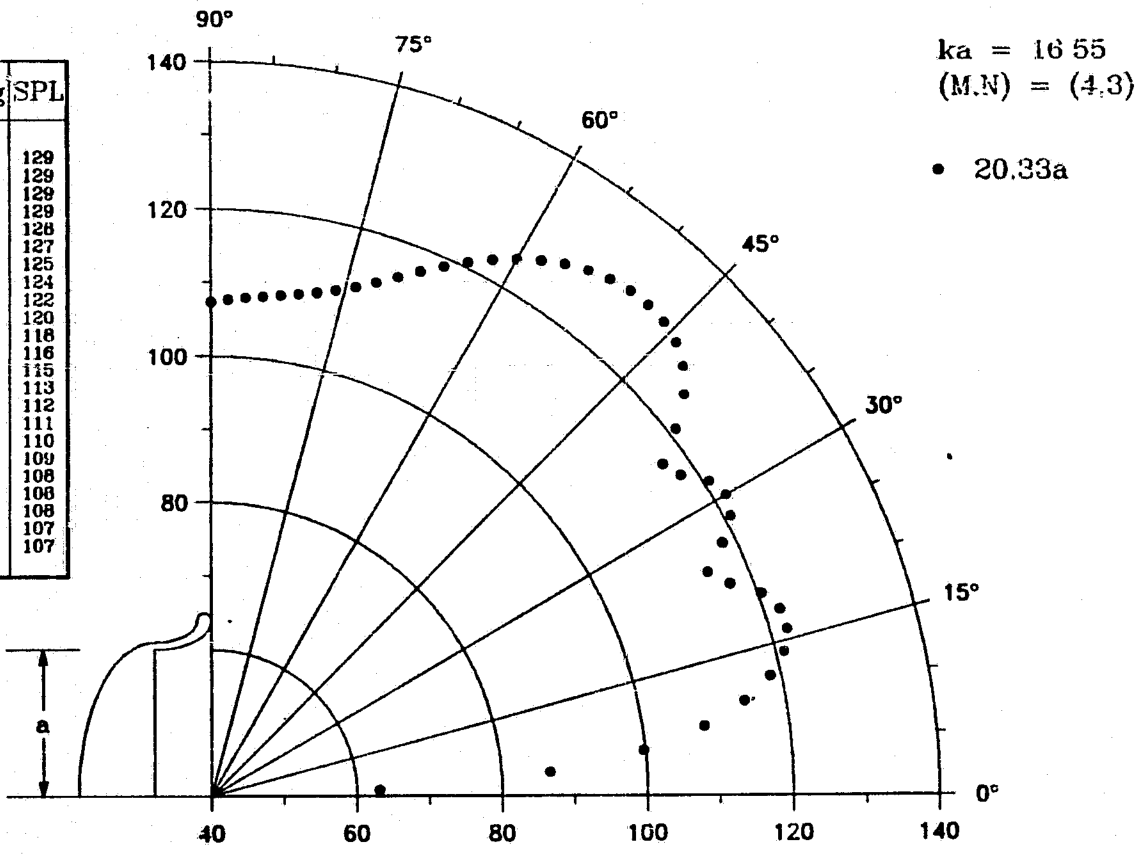


Fig. 45e

THICK LIPPED ELLIPTICAL INLET

Deg	SPL	Deg	SPL
0	0	46	130
2	70	48	128
4	94	50	124
6	107	52	120
8	115	54	115
10	120	56	114
12	123	58	115
14	124	60	110
16	123	62	116
18	120	64	116
20	118	66	115
22	122	68	114
24	124	70	113
26	124	72	112
28	121	74	112
30	121	76	111
32	127	78	110
34	130	80	109
36	133	82	109
38	134	84	108
40	134	86	108
42	133	88	107
44	132	90	107

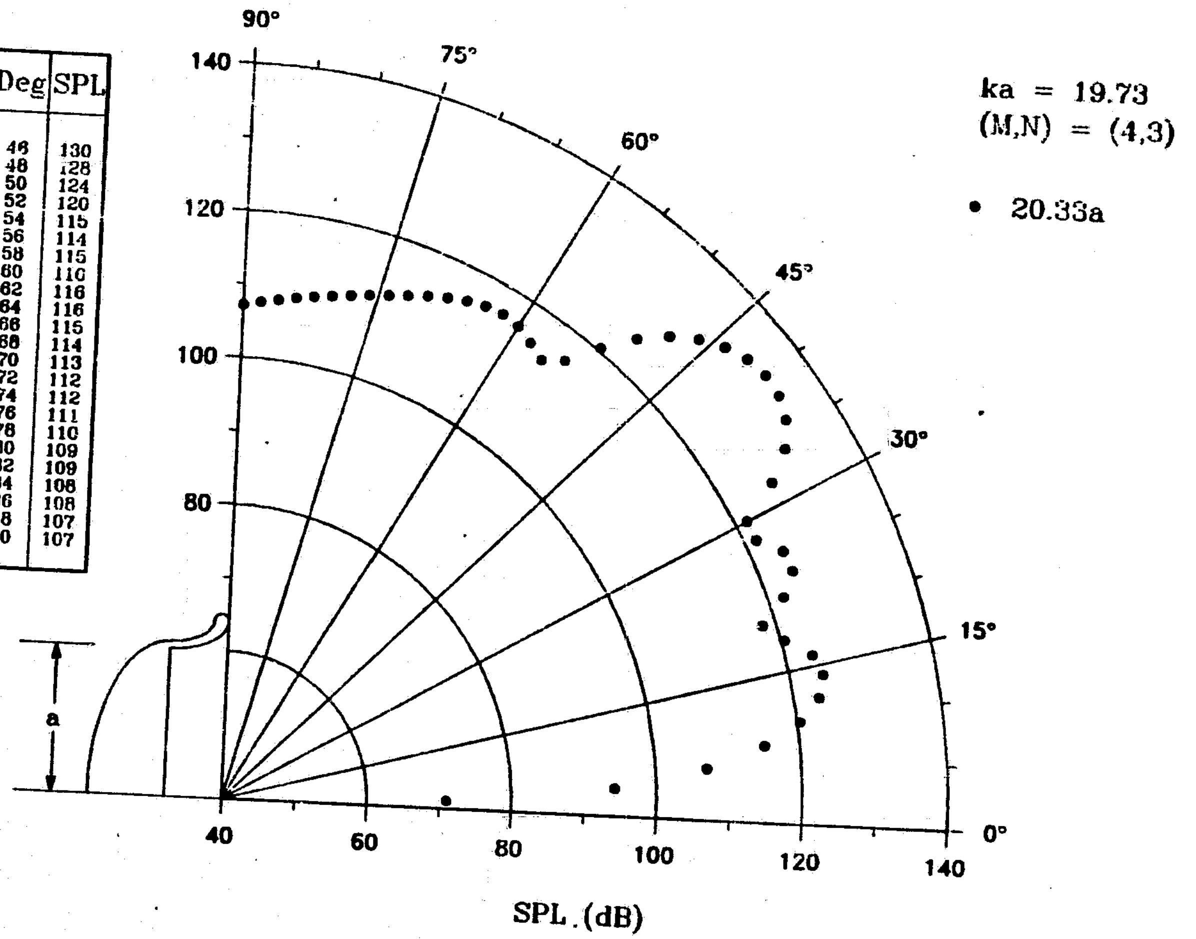


Fig. 45f

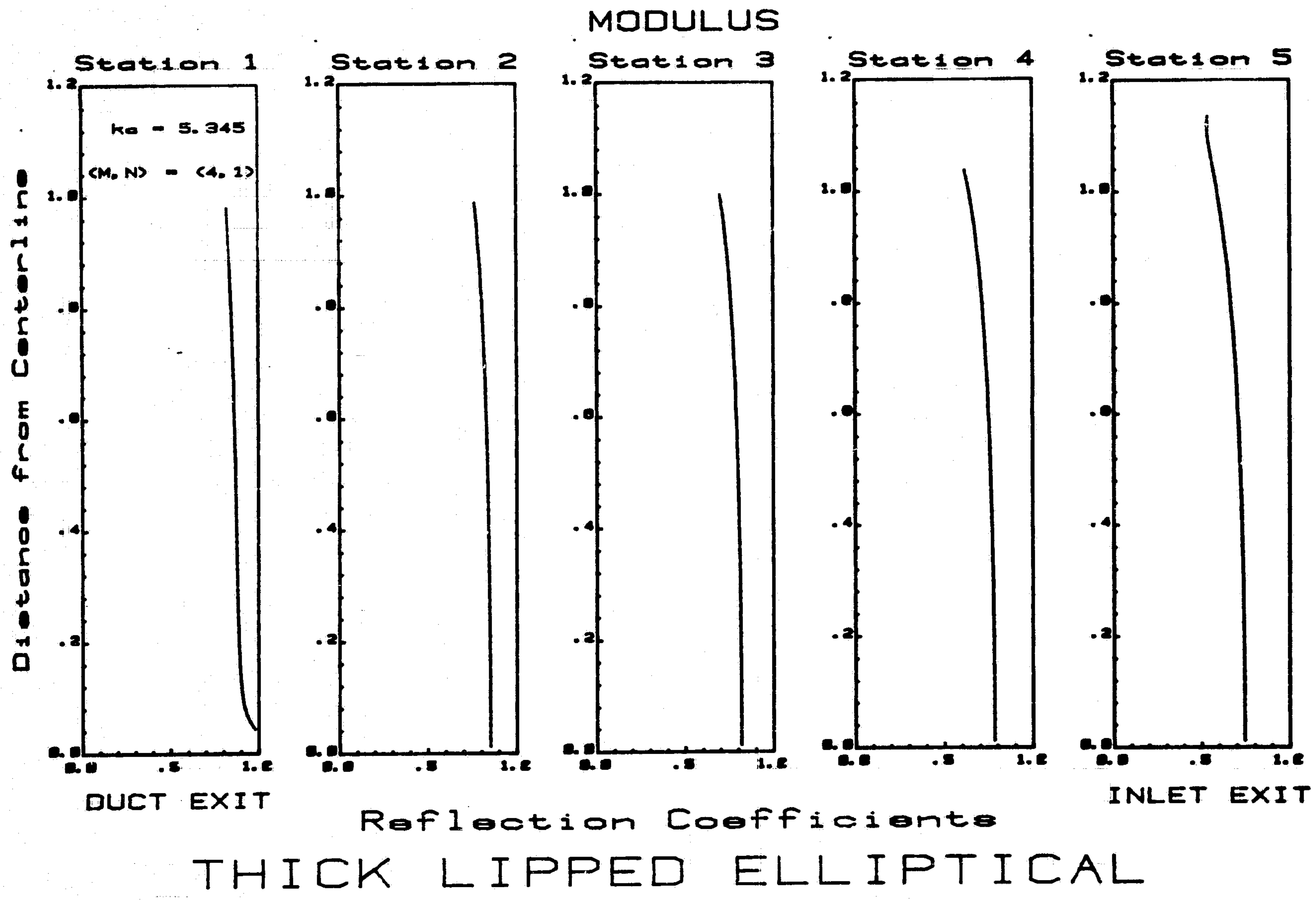

MODULUS
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 5.345
(M, N) = (4, 1)
Distance from Centerline
1.2
1.0
.8
.6
.4
.2
0.0
.5
DUCT EXIT
INLET EXIT
Reflection Coefficients
THICK LIPPED ELLIPTICAL

Fig. 46a

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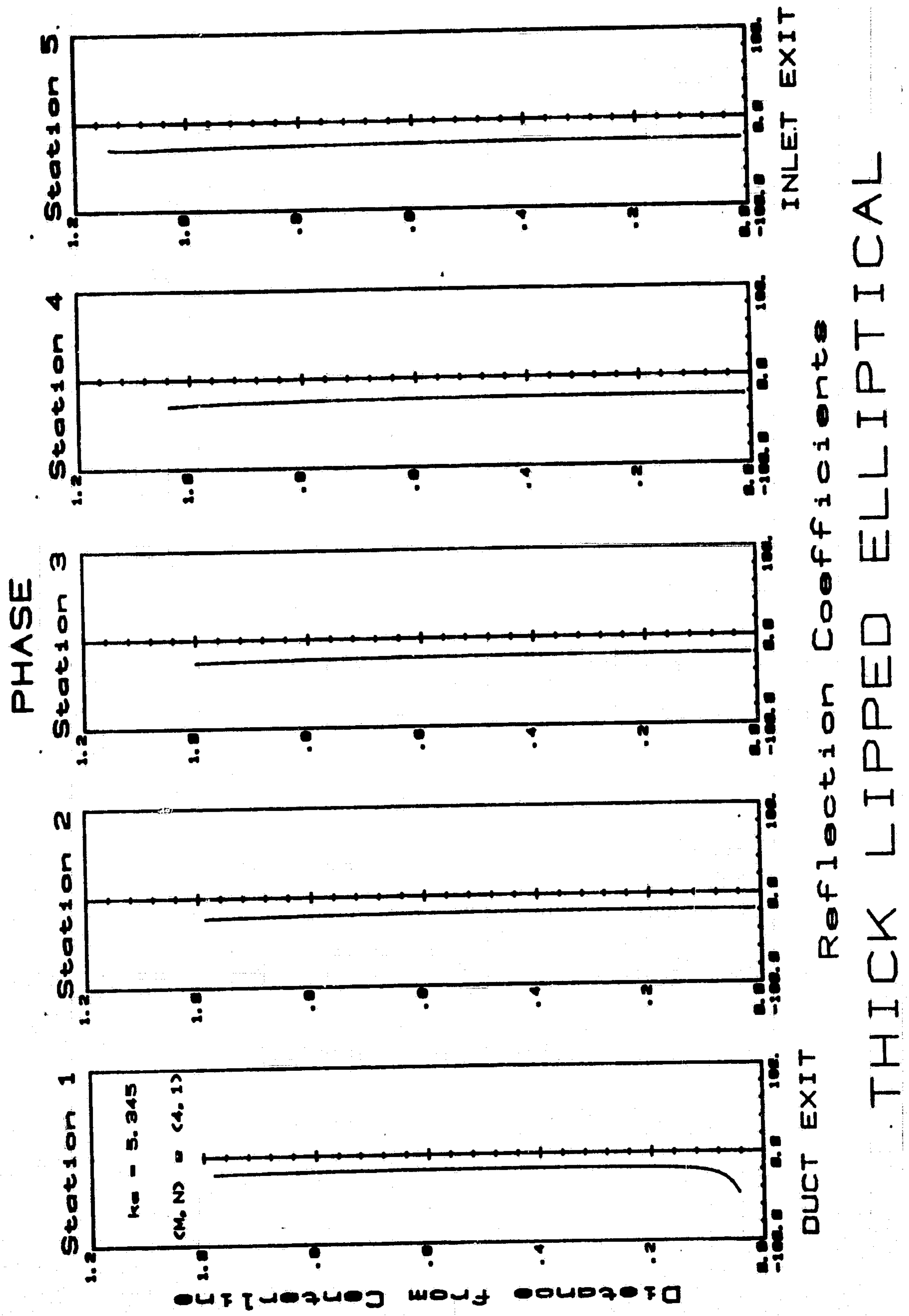

Fig. 46b

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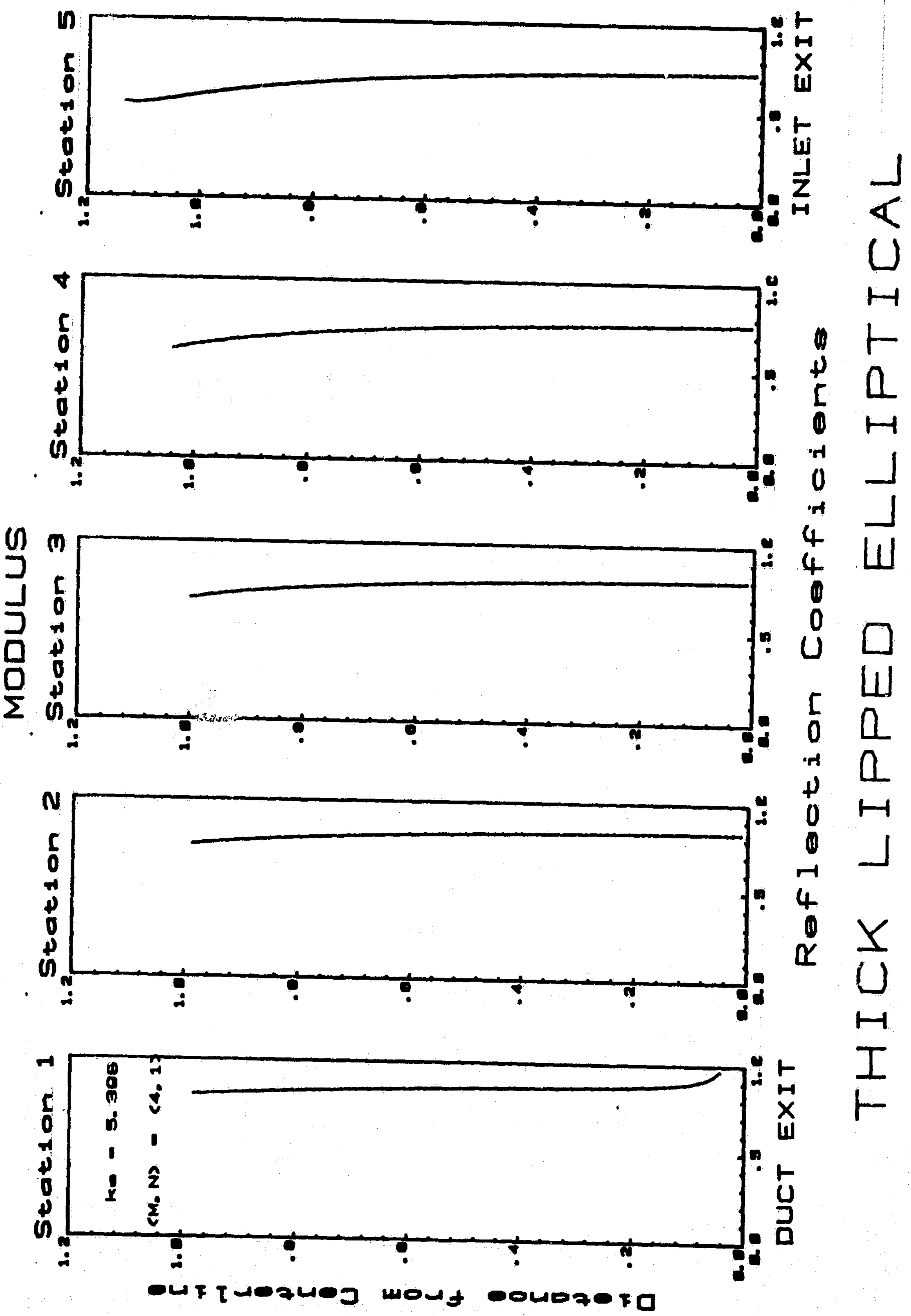


Fig. 46c

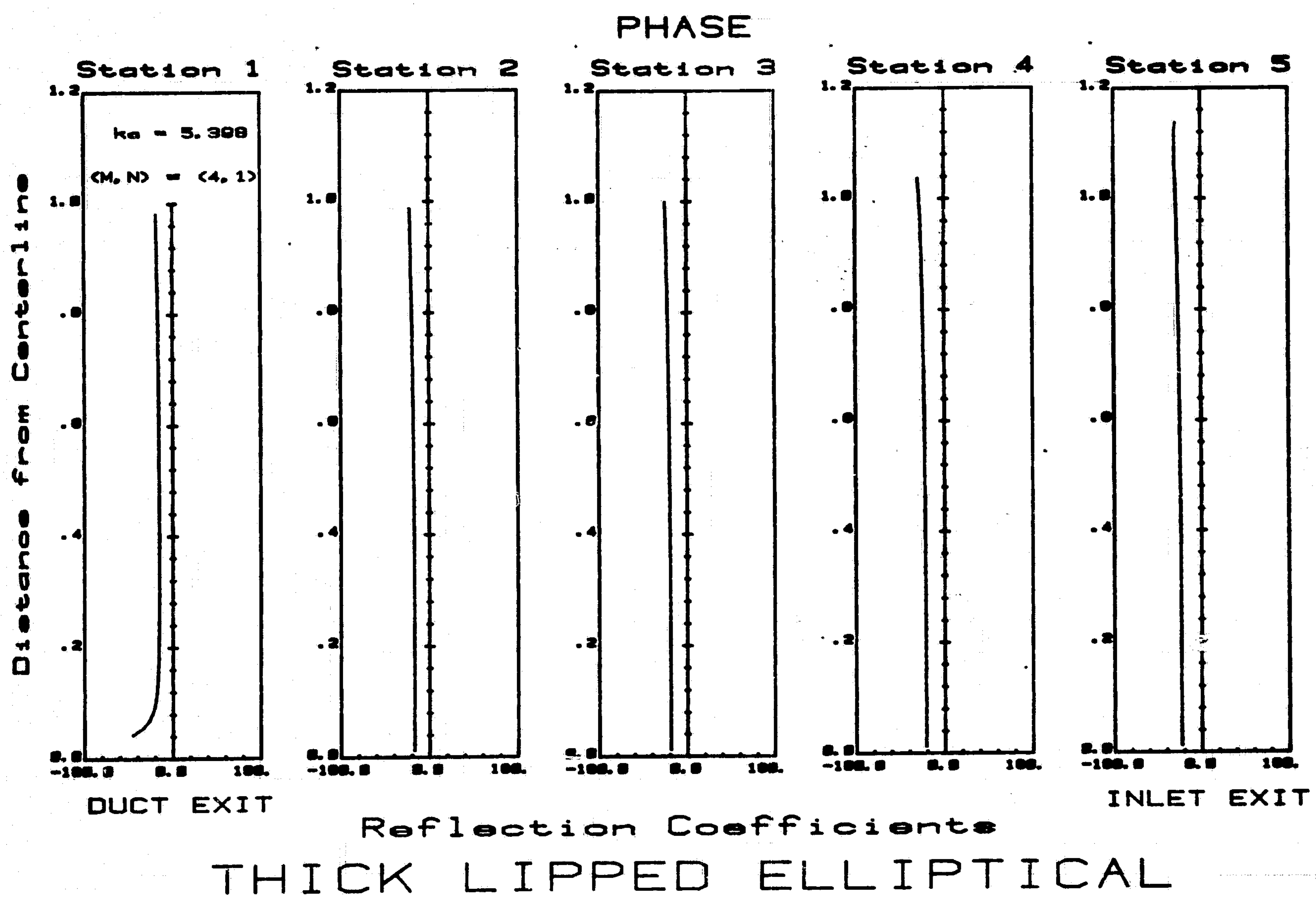

PHASE
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 5.308
(M, N) = (4, 1)
Distance from Centerline
1.2
1.0
.8
.6
.4
.2
0.0
-100.0
0.0
100.
DUCT EXIT
INLET EXIT
Reflection Coefficients
THICK LIPPED ELLIPTICAL

Fig. 46d

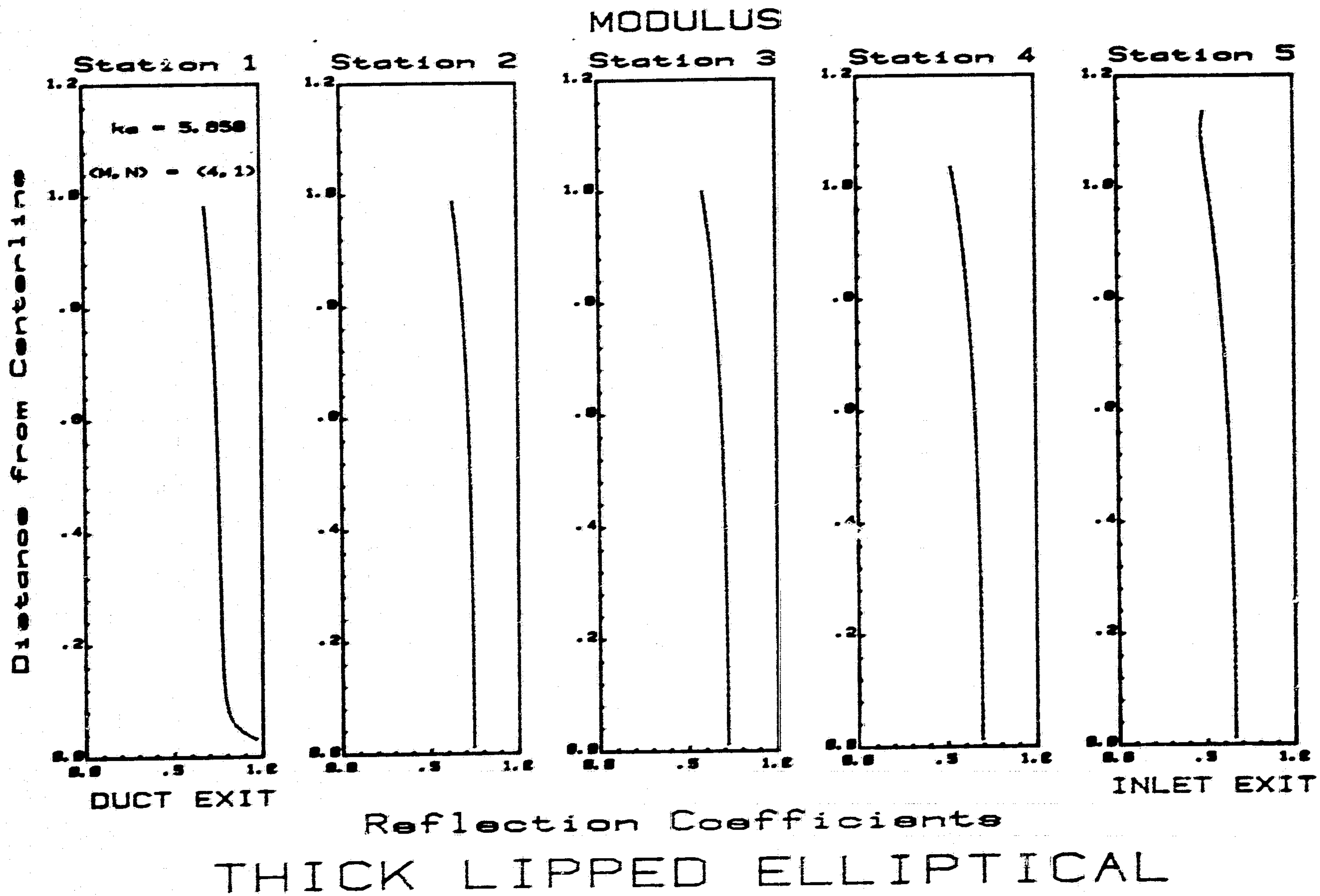

MODULUS
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 5.858
(M, N) = (4, 1)
Distance from Centerline
DUCT EXIT
INLET EXIT
Reflection Coefficients
THICK LIPPED ELLIPTICAL

Fig. 46e

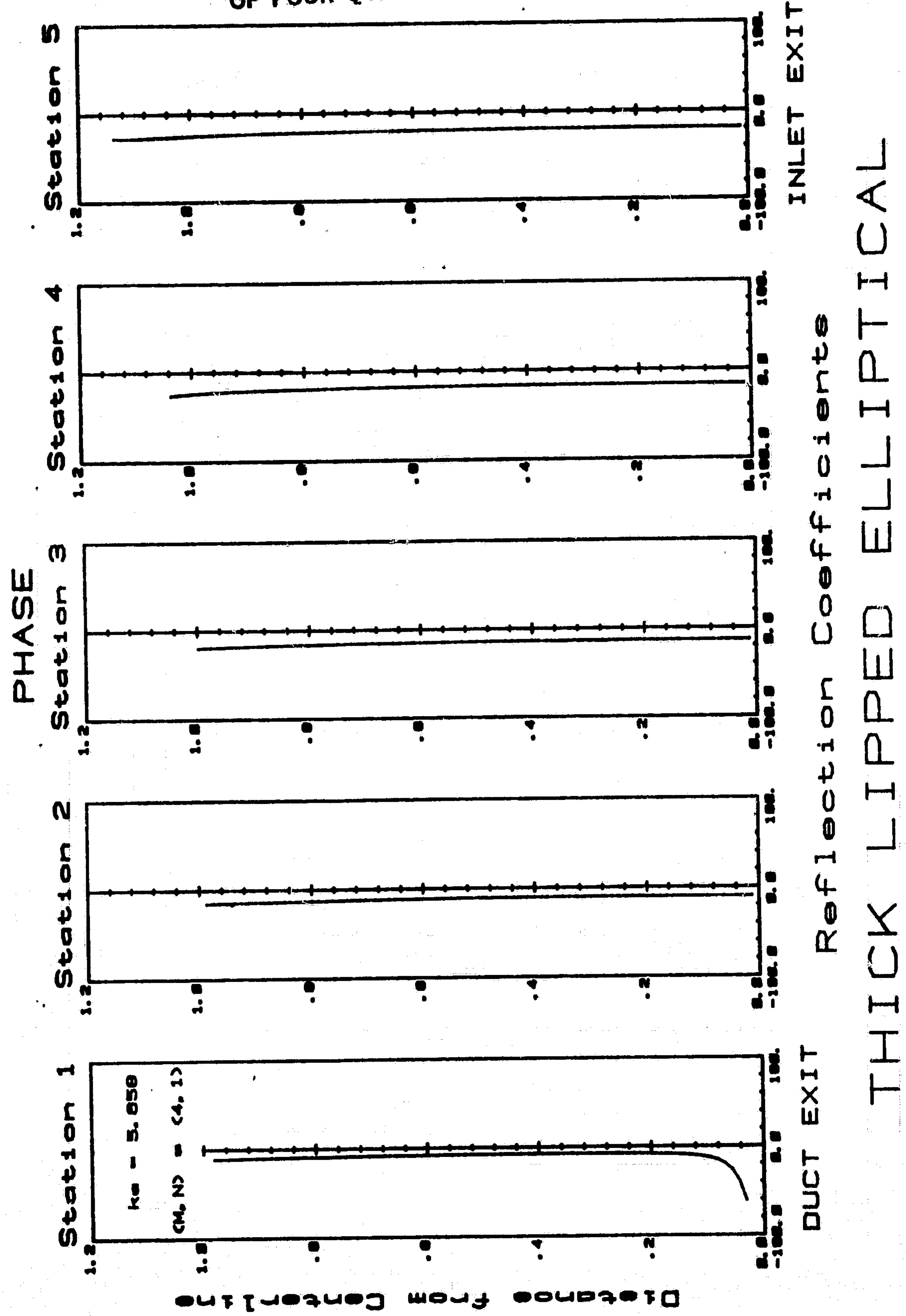

PHASE
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 5.850
(M, N) = (4, 1)
DUCT EXIT
INLET EXIT
Distance From Centerline
Reflection Coefficients
THICK LIPPED ELLIPTICAL

Fig. 46f

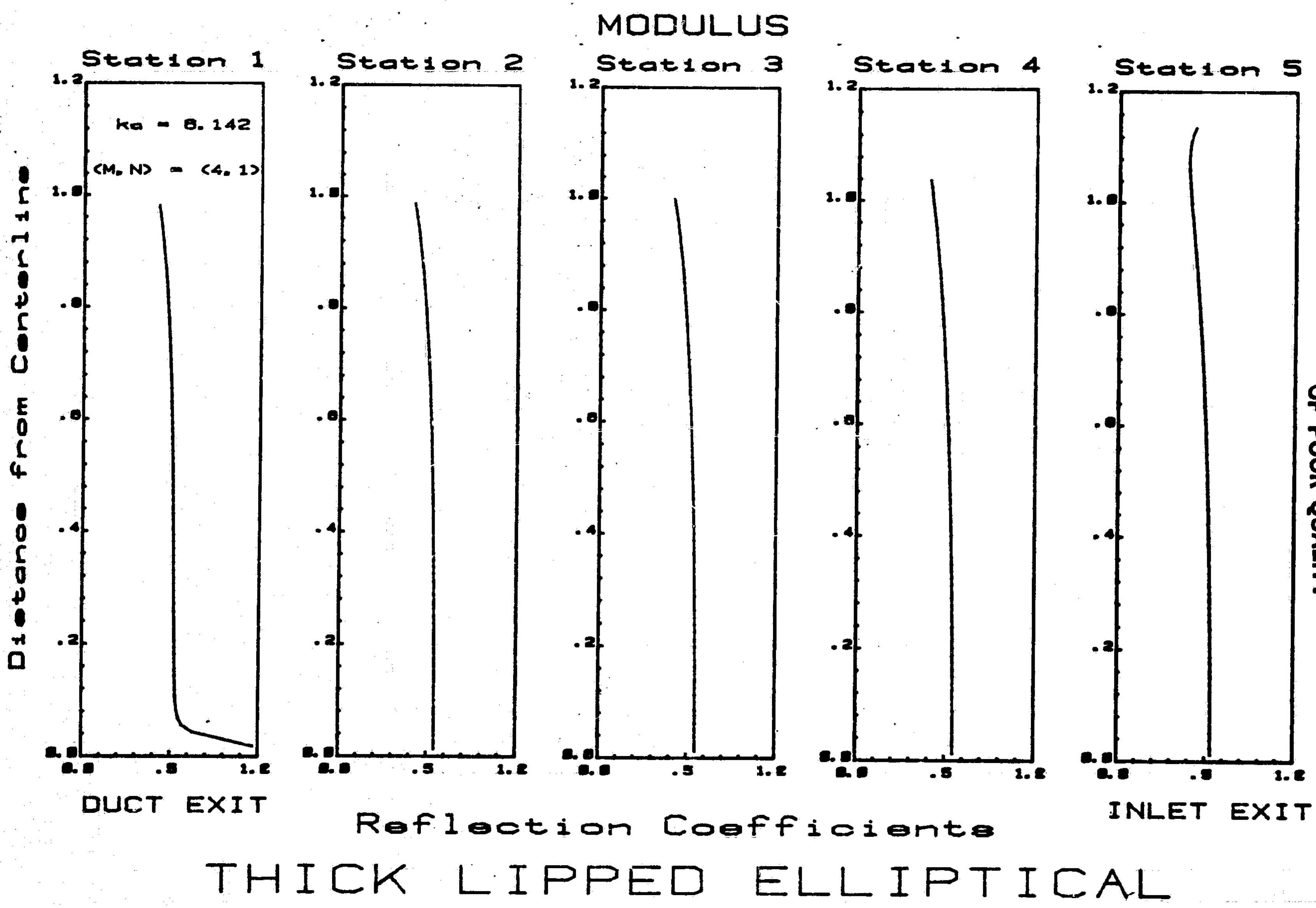
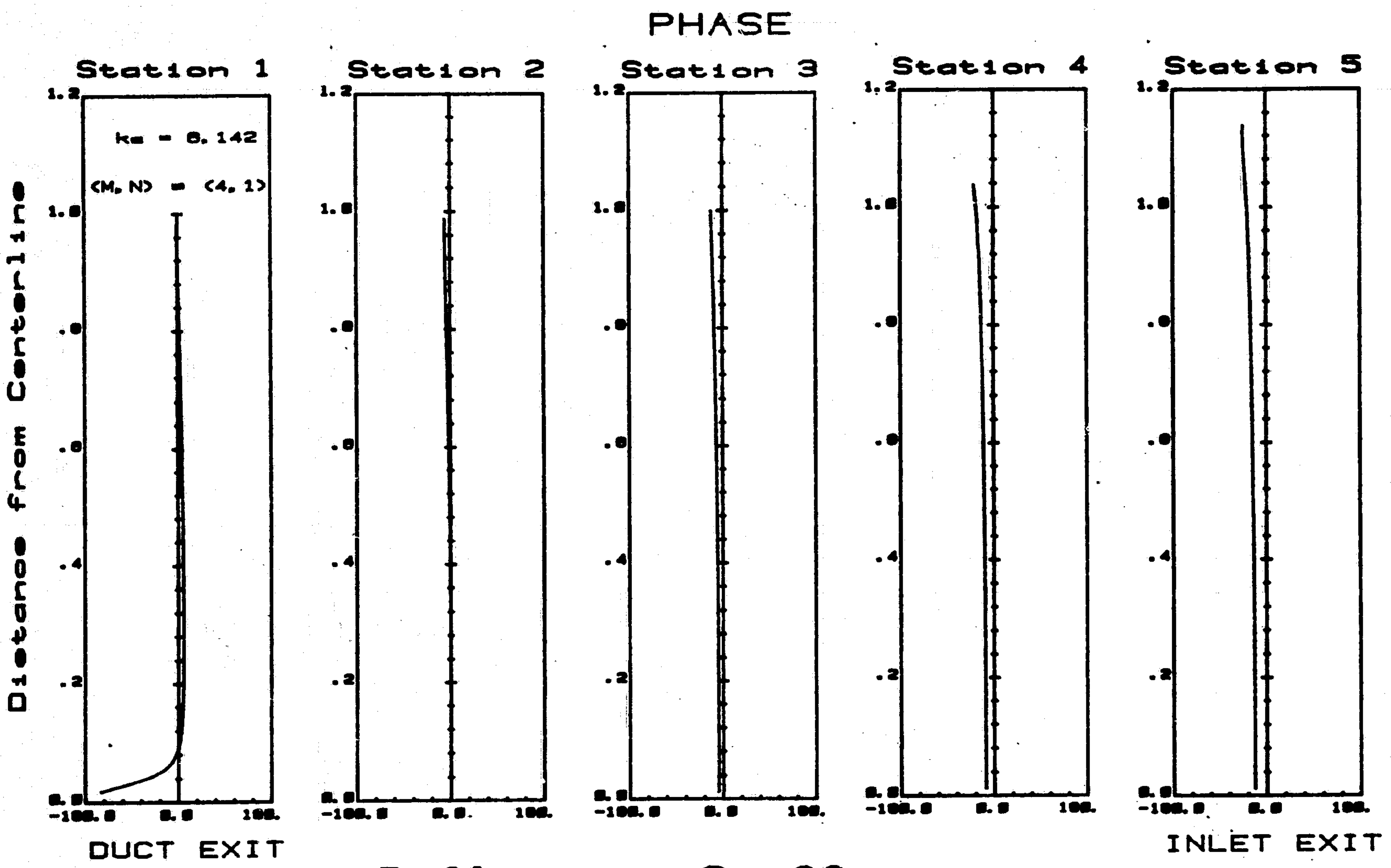
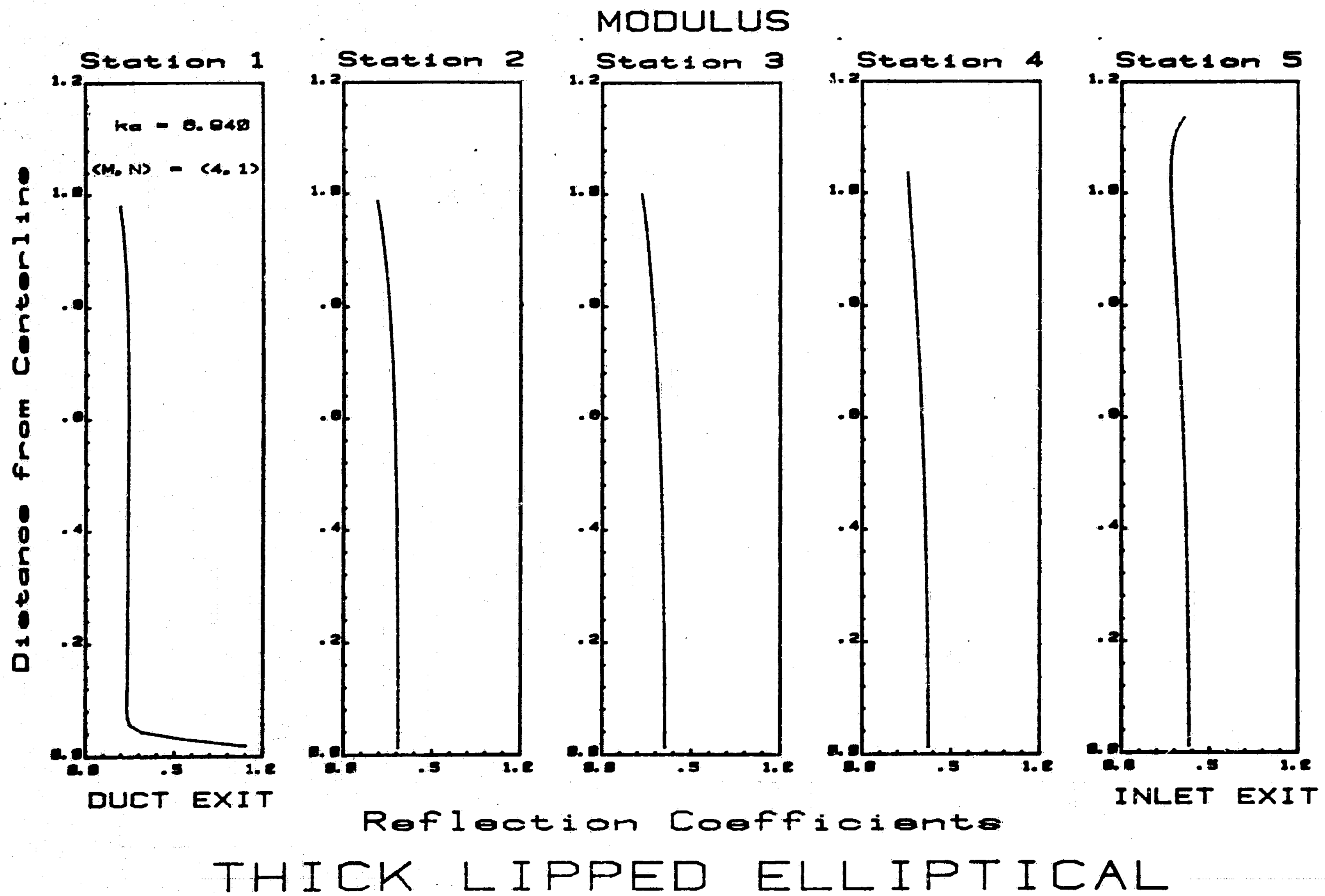

MODULUS
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 8.142
(M, N) = (4, 1)
Distance from Centerline
1.2
1.0
.8
.6
.4
.2
0.0
.5
DUCT EXIT
INLET EXIT
Reflection Coefficients
THICK LIPPED ELLIPTICAL

Fig. 46g

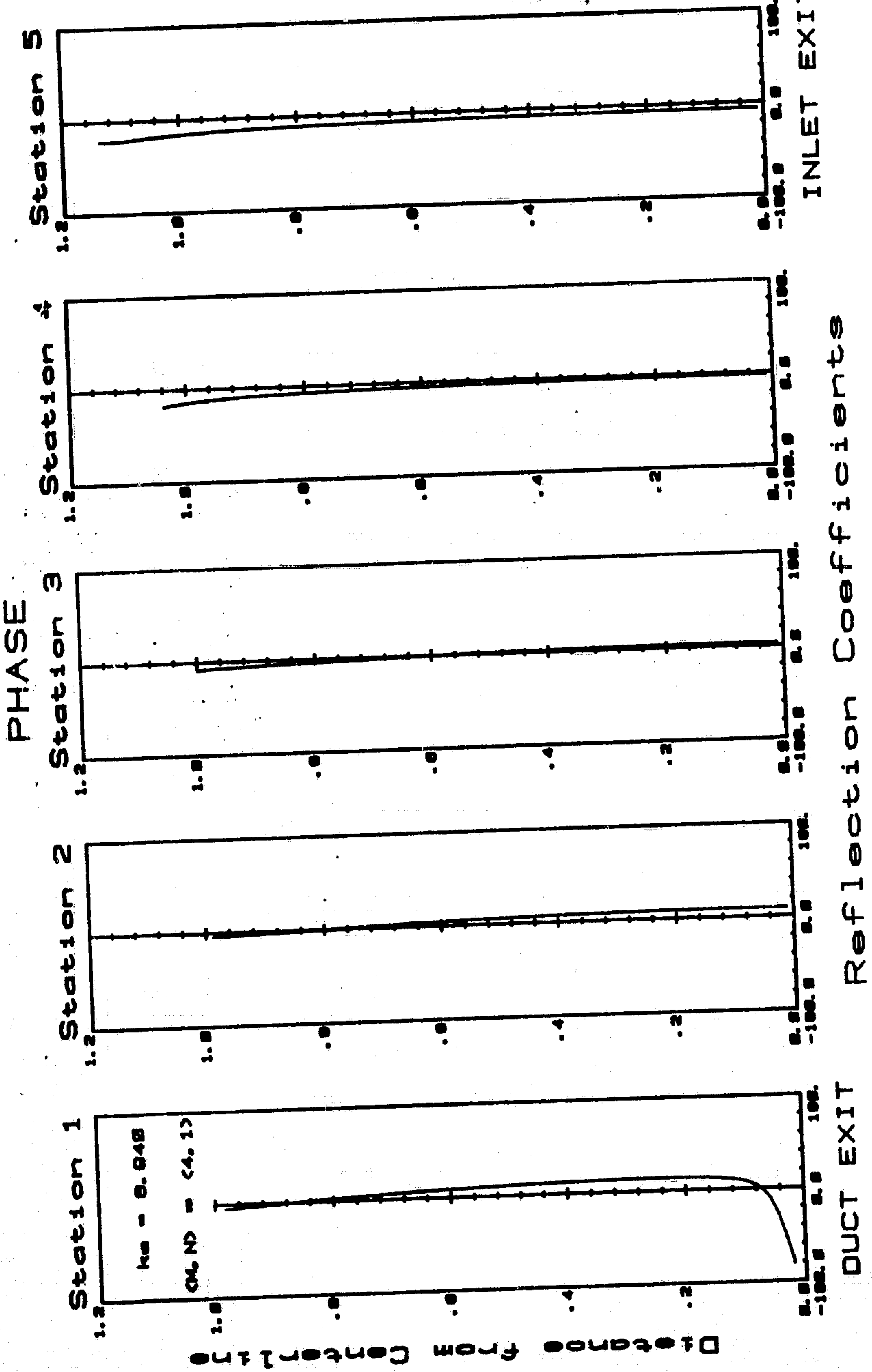


THICK LIPPED ELLIPTICAL

Fig. 46h


MODULUS
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 0.940
(M, N) = (4, 1)
Distance from Centerline
1.2
1.0
.8
.6
.4
.2
0.0
.5
DUCT EXIT
INLET EXIT
Reflection Coefficients
THICK LIPPED ELLIPTICAL

Fig, 46i



THICK LIPPED ELLIPTICAL

Fig. 46j

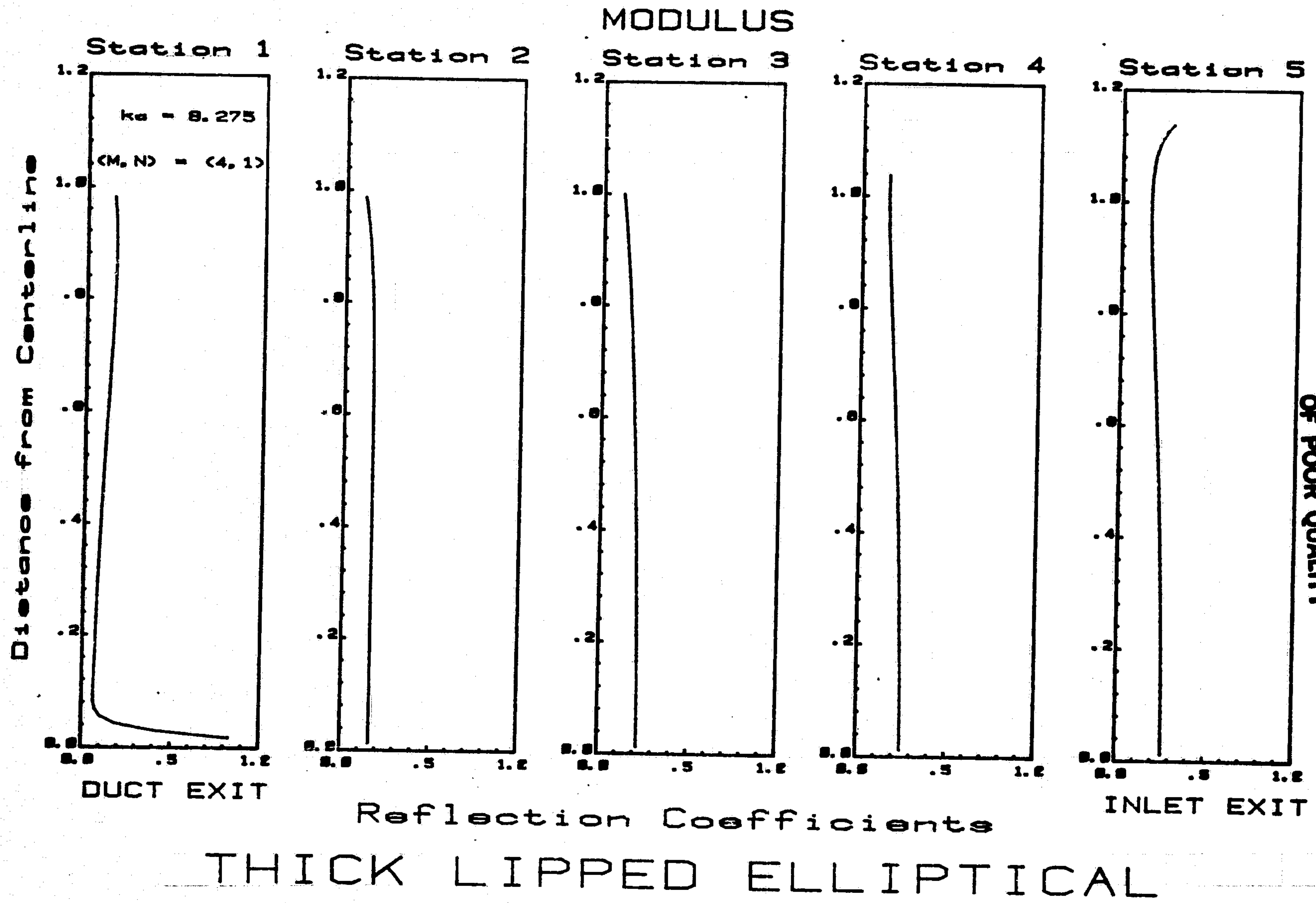
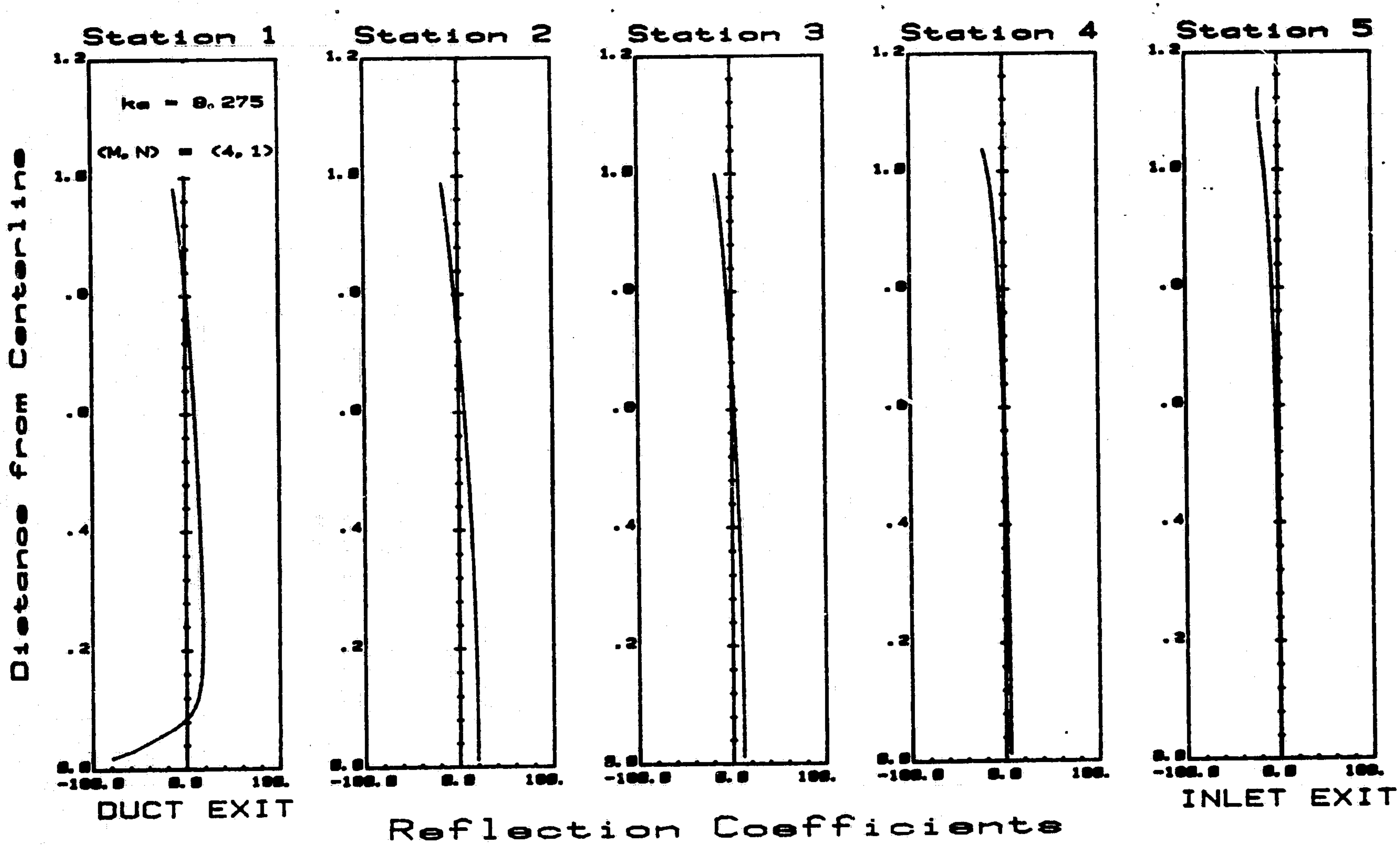

MODULUS
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 8.275
(M, N) = (4, 1)
Distance from Centerline
1.2
1.0
.8
.6
.4
.2
0.0
.5
DUCT EXIT
INLET EXIT
Reflection Coefficients
THICK LIPPED ELLIPTICAL

Fig. 46k



THICK LIPPED ELLIPTICAL

Fig. 461

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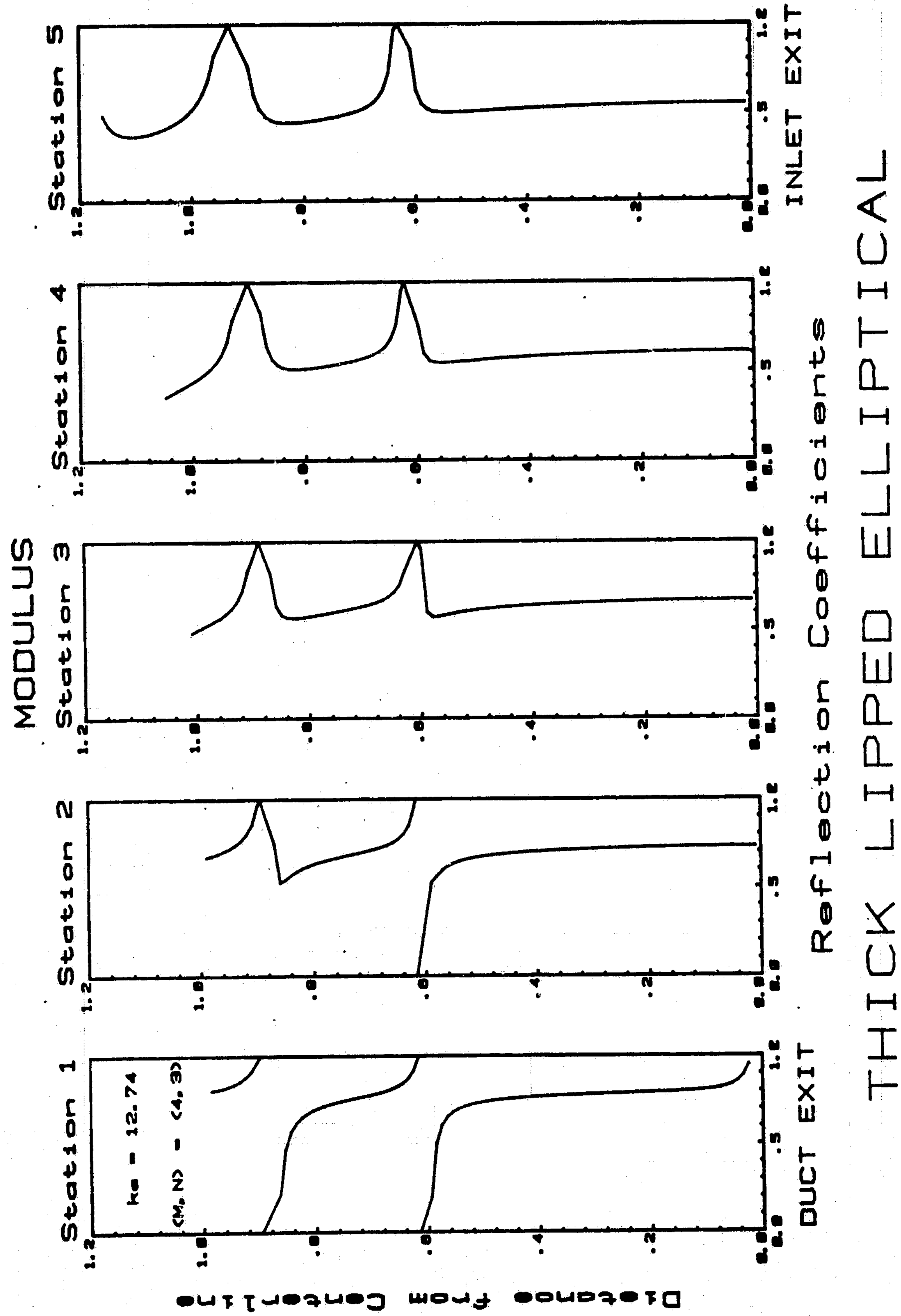
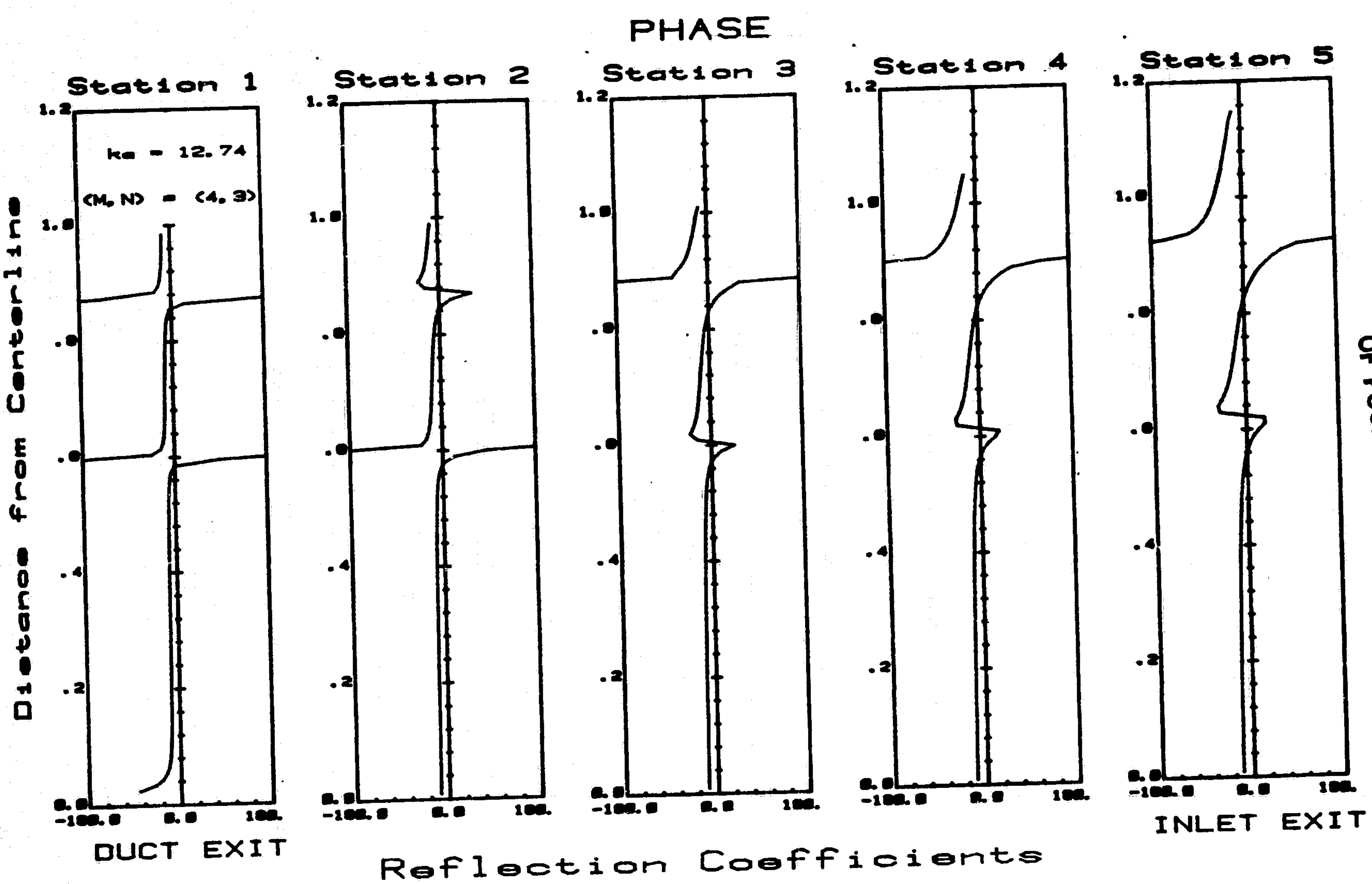


Fig. 47a



THICK LIPPED ELLIPTICAL

Fig. 47b

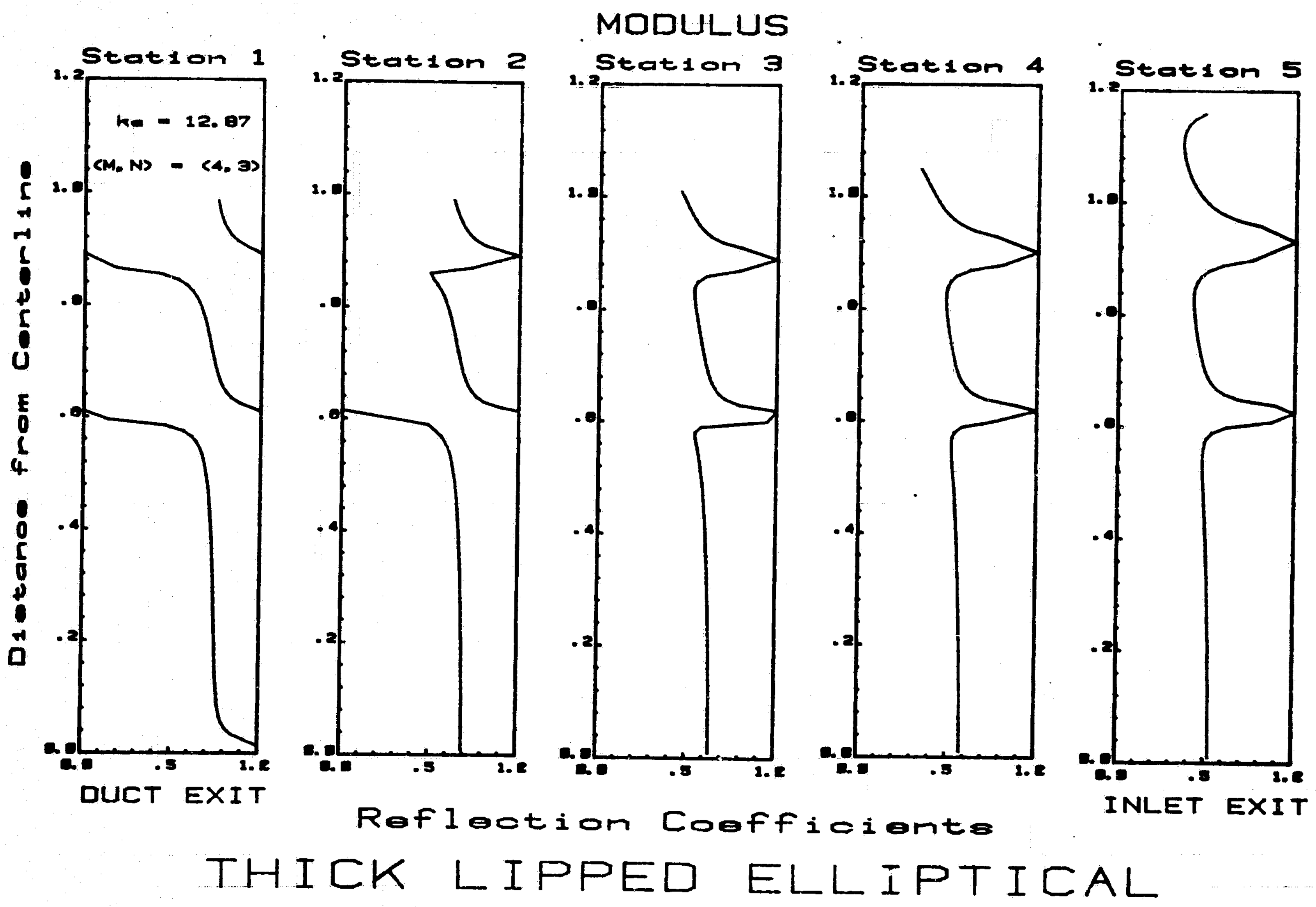


Fig. 47c

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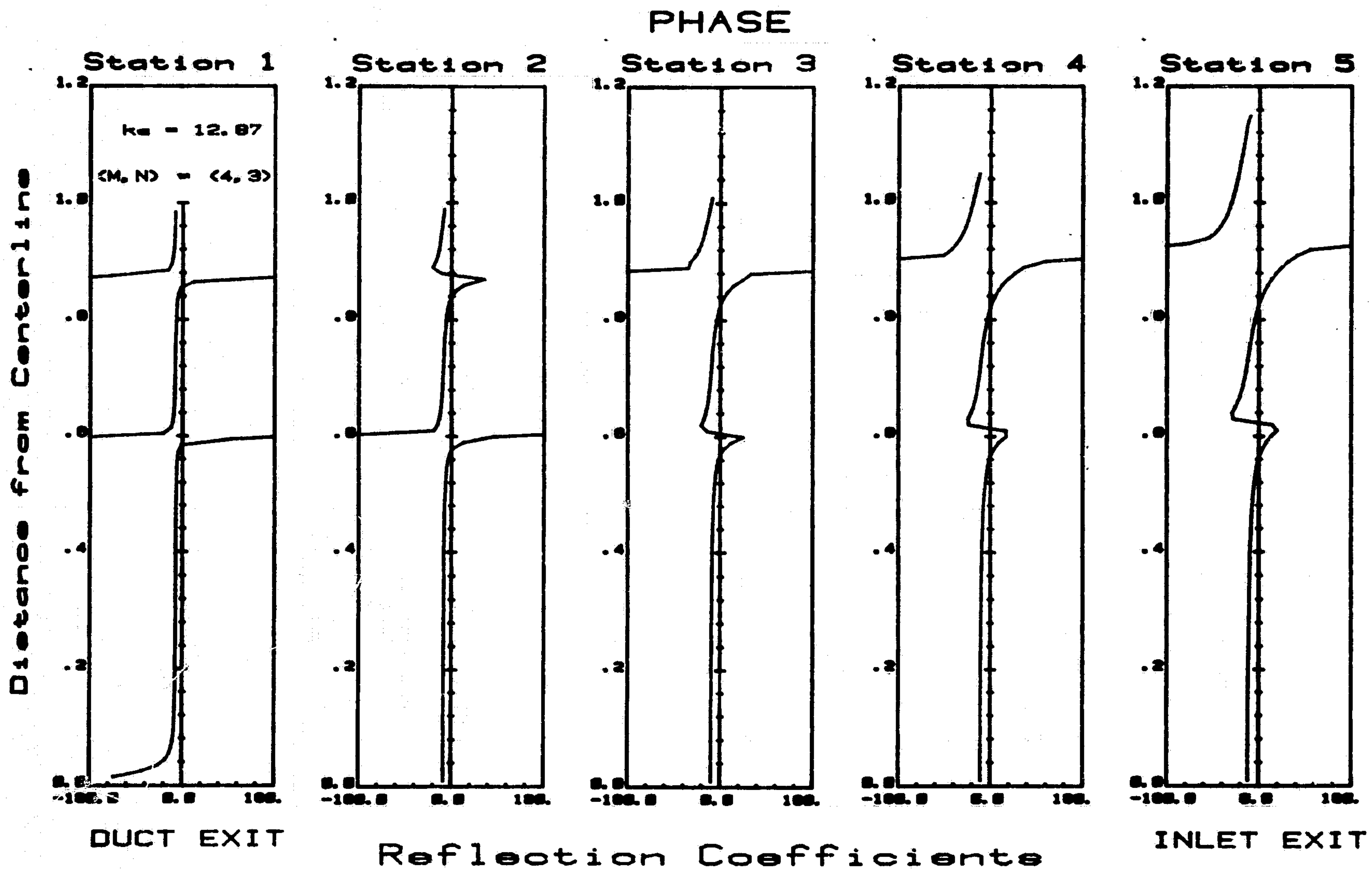
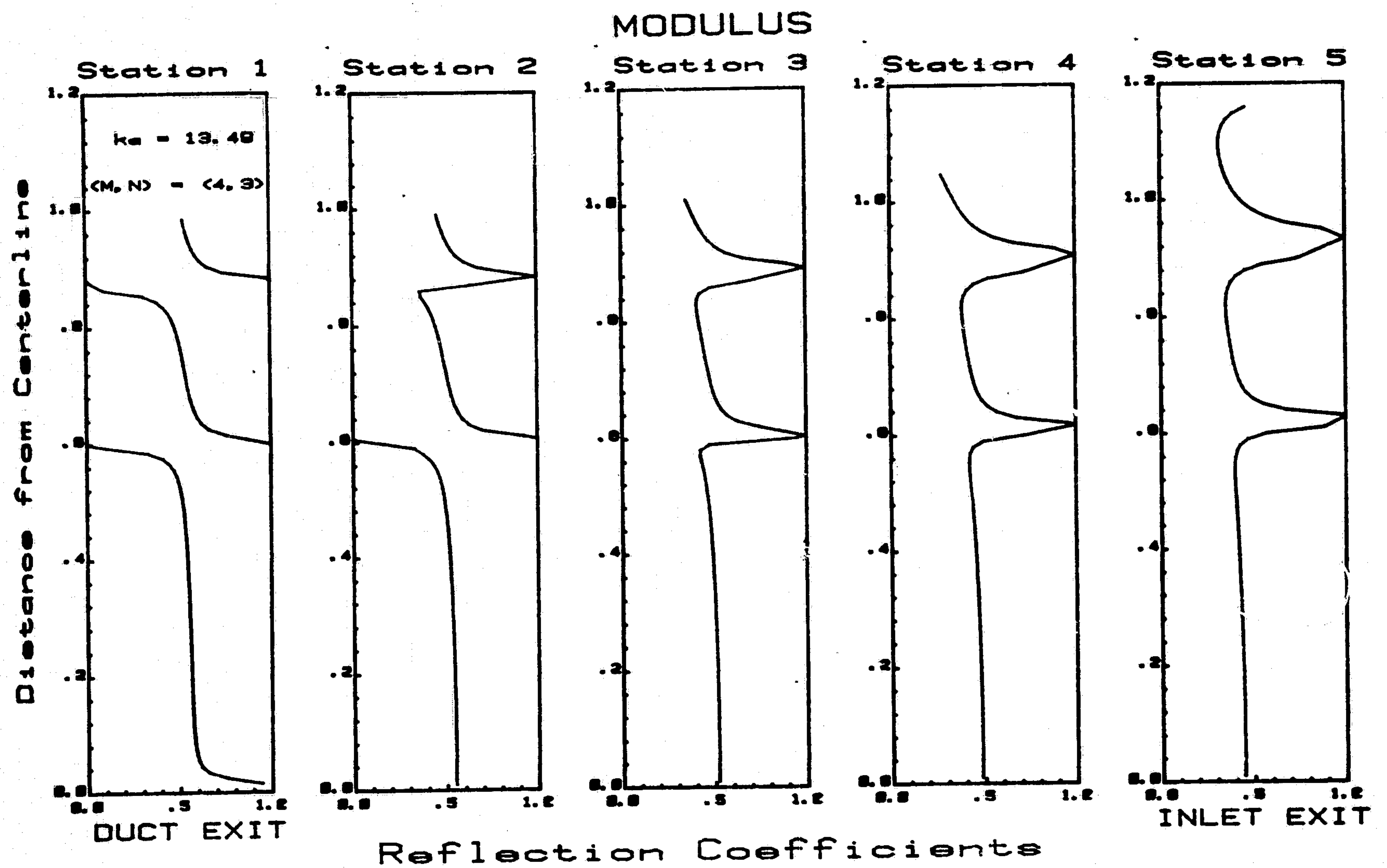


THICK LIPPED ELLIPTICAL

Fig. 47d



THICK LIPPED ELLIPTICAL

Fig. 47e

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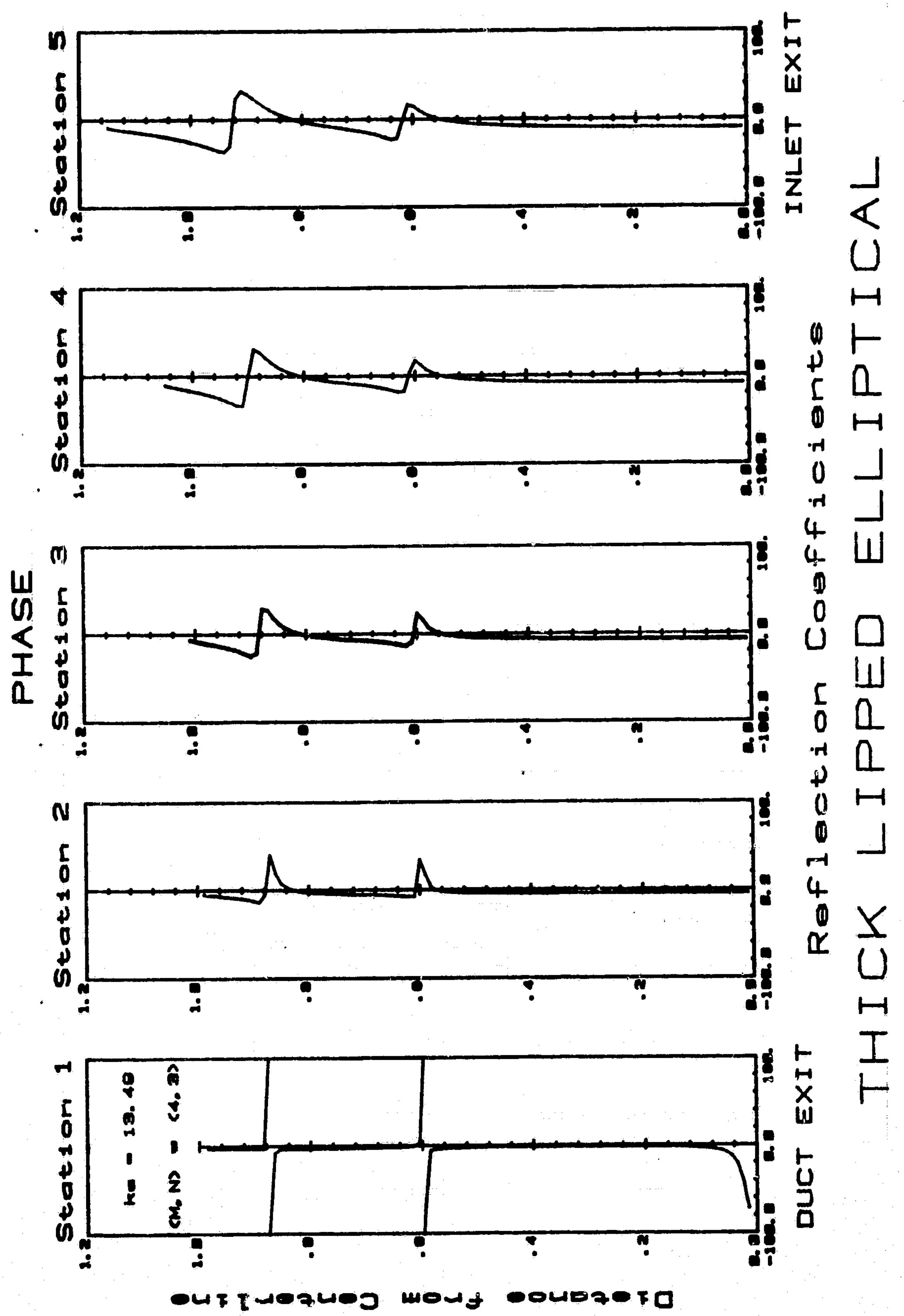


Fig. 47f

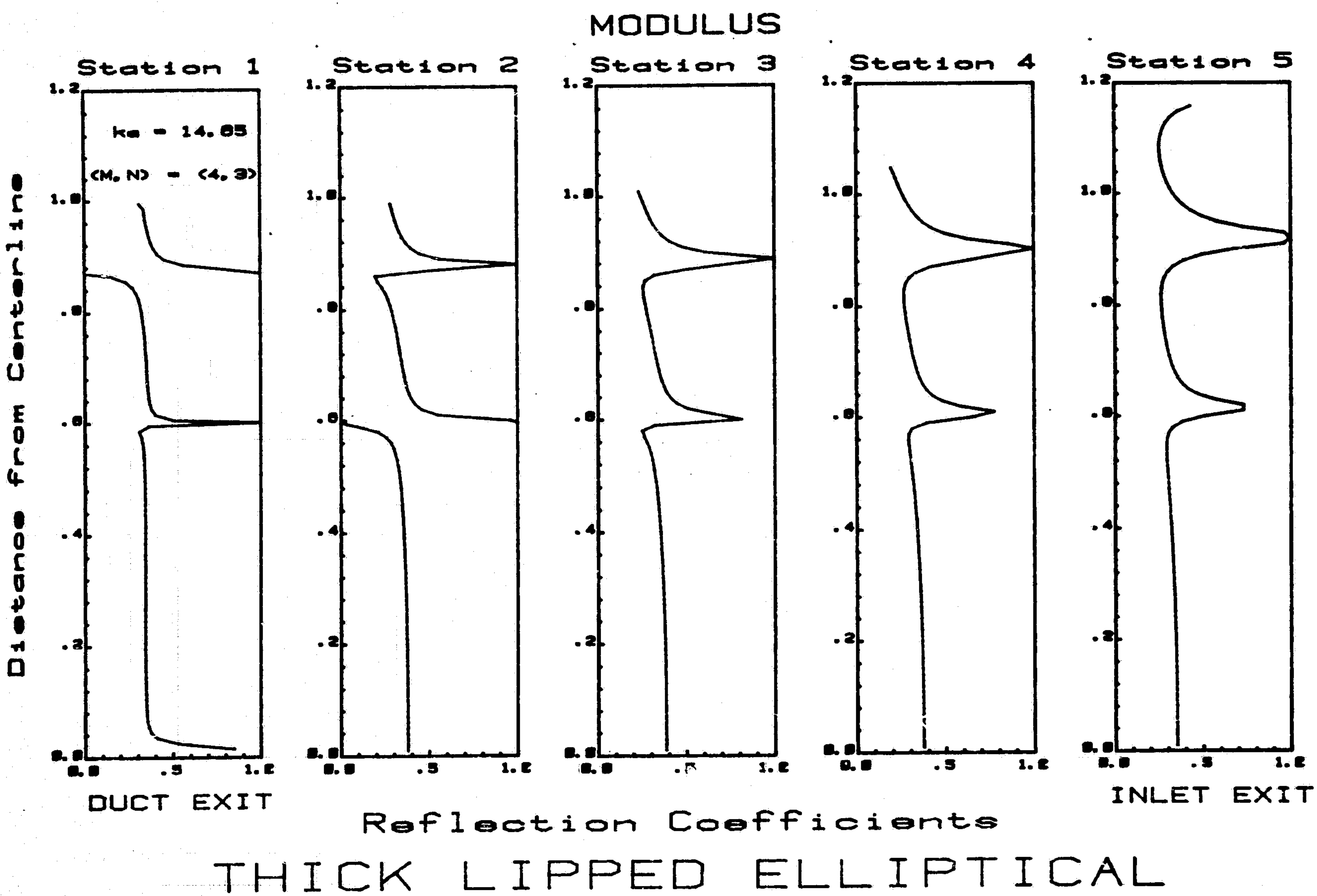

MODULUS
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 14.85
(M, N) = (4, 3)
Distance from Centerline
1.2
1.0
.8
.6
.4
.2
0.0
.5
DUCT EXIT
INLET EXIT
Reflection Coefficients
THICK LIPPED ELLIPTICAL

Fig. 47g

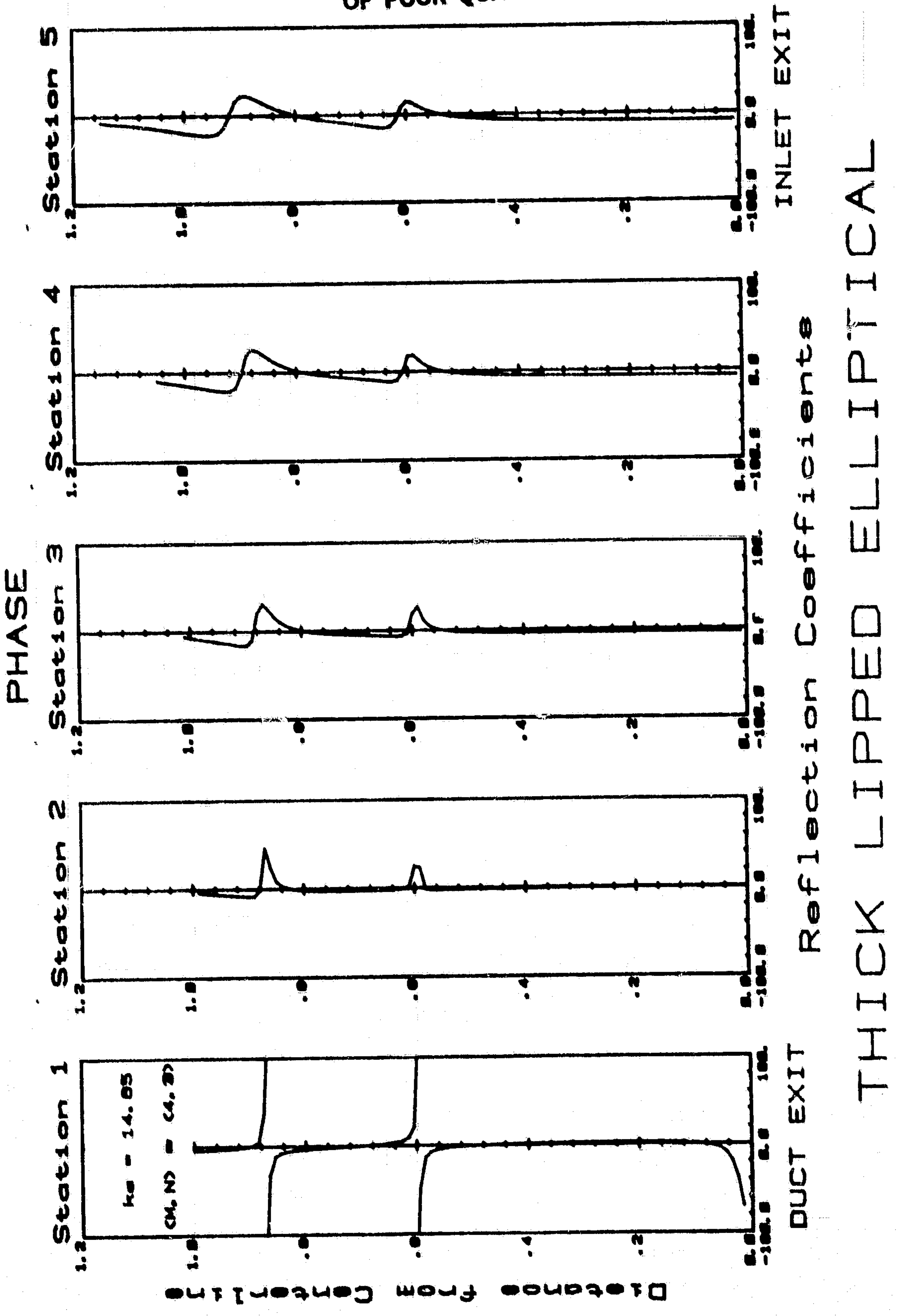

THICK LIPPED ELLIPTICAL
Reflection Coefficients
PHASE
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 14.85
(M, N) = (4, 3)
DUCT EXIT
INLET EXIT
Distance from Centerline

Fig. 47n

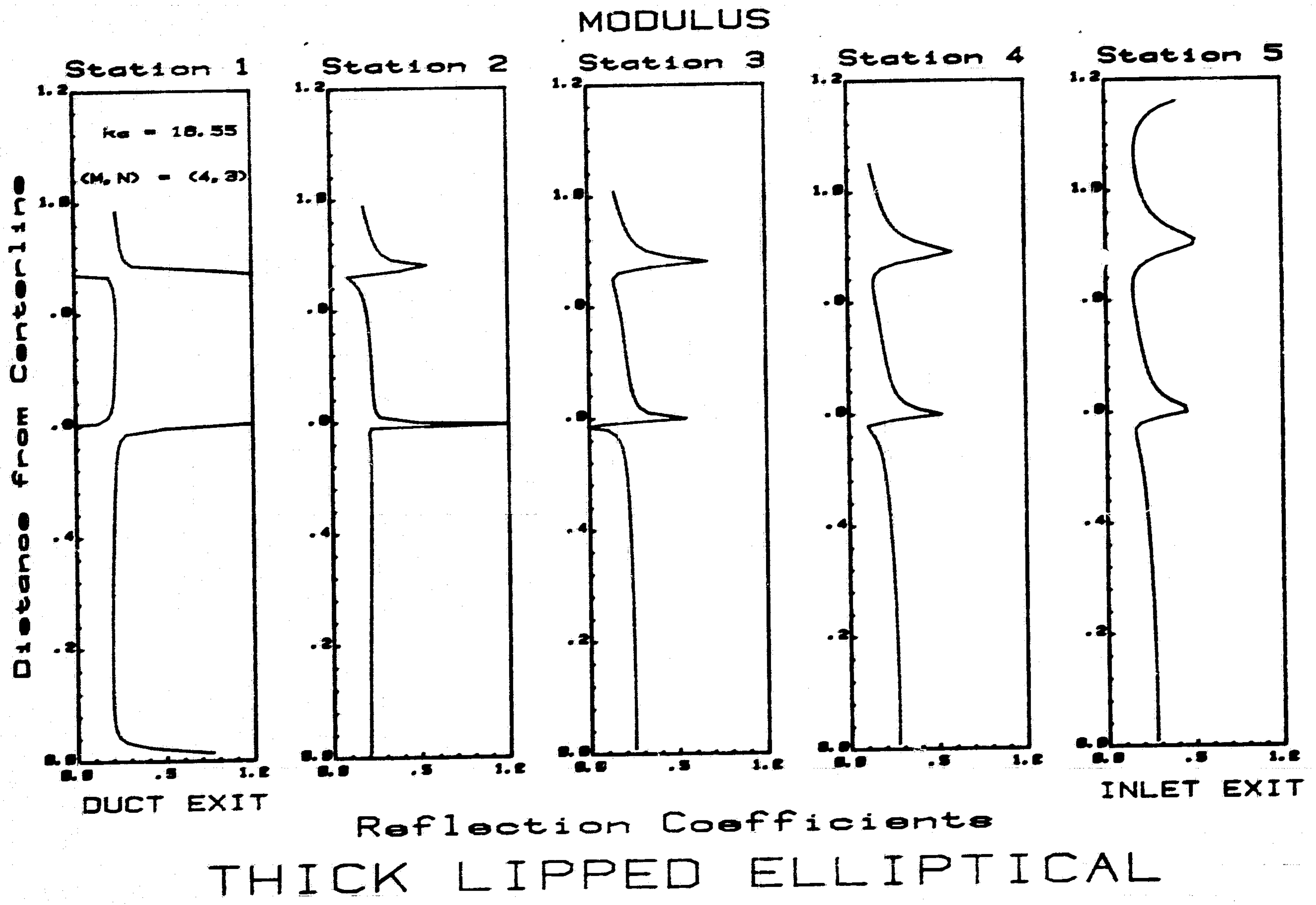
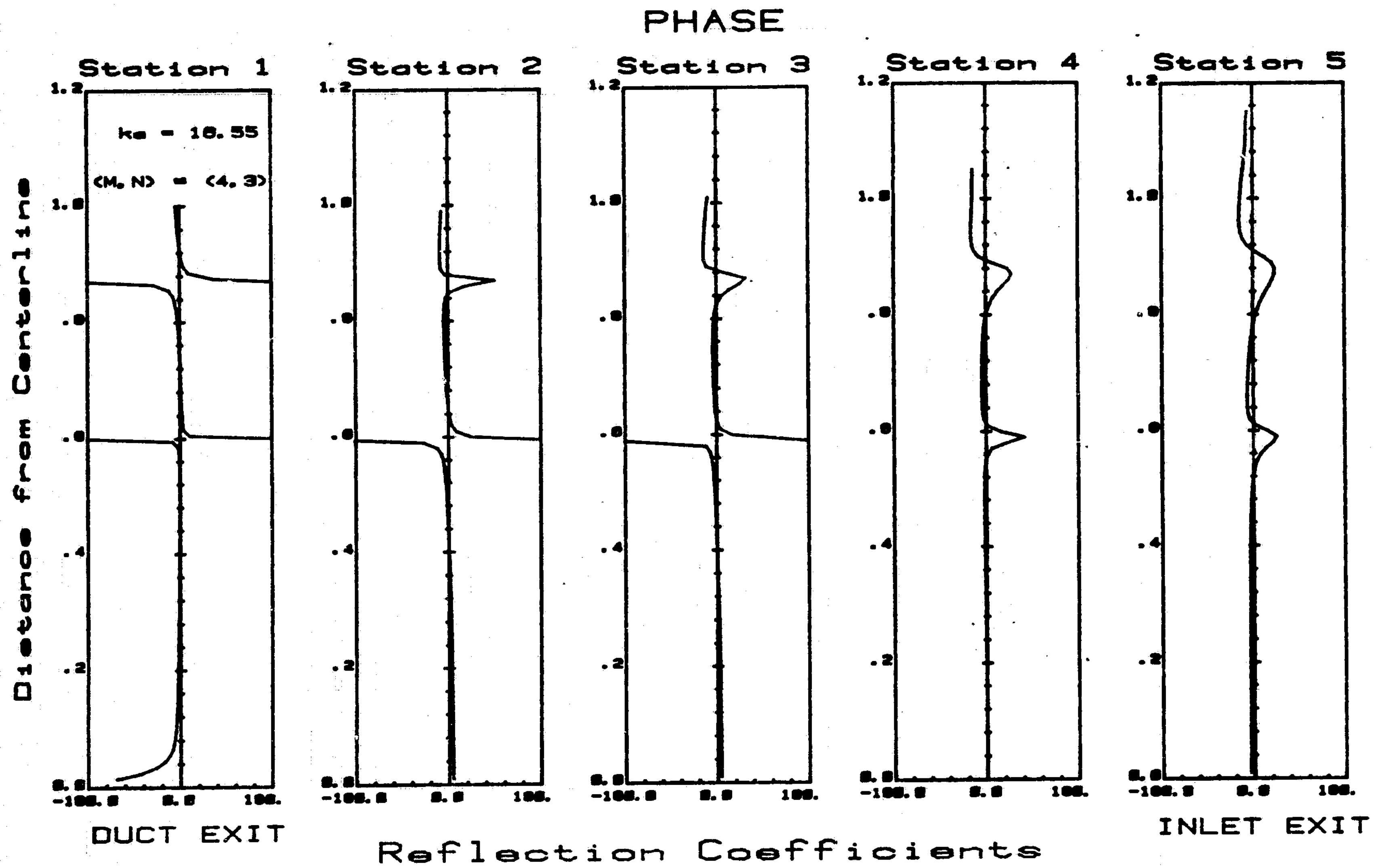

MODULUS
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 18.55
(M, N) = (4, 3)
Distance from Centerline
1.2
1.0
.8
.6
.4
.2
0.0
.5
DUCT EXIT
INLET EXIT
Reflection Coefficients
THICK LIPPED ELLIPTICAL

Fig. 47i



THICK LIPPED ELLIPTICAL

Fig. 47j

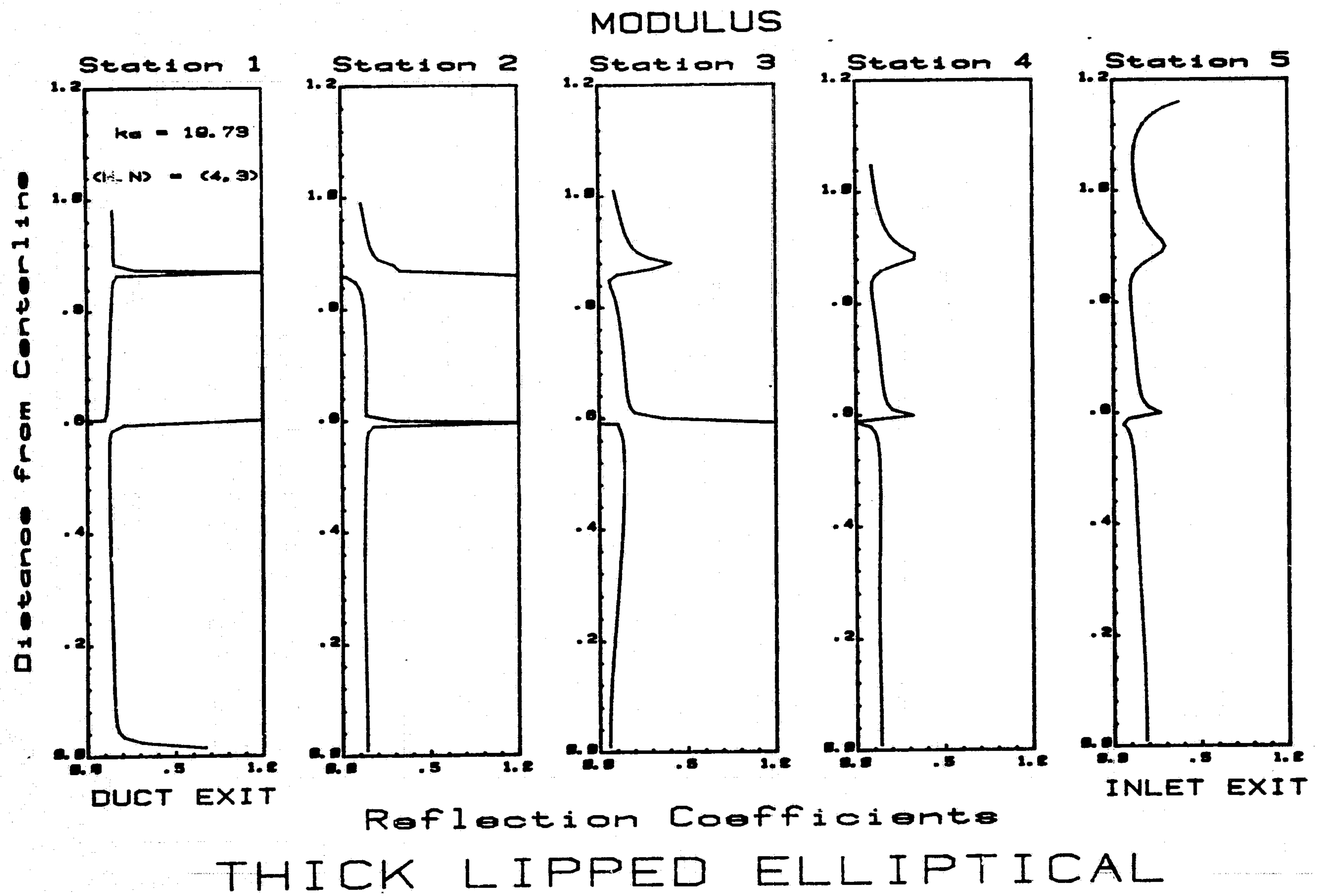
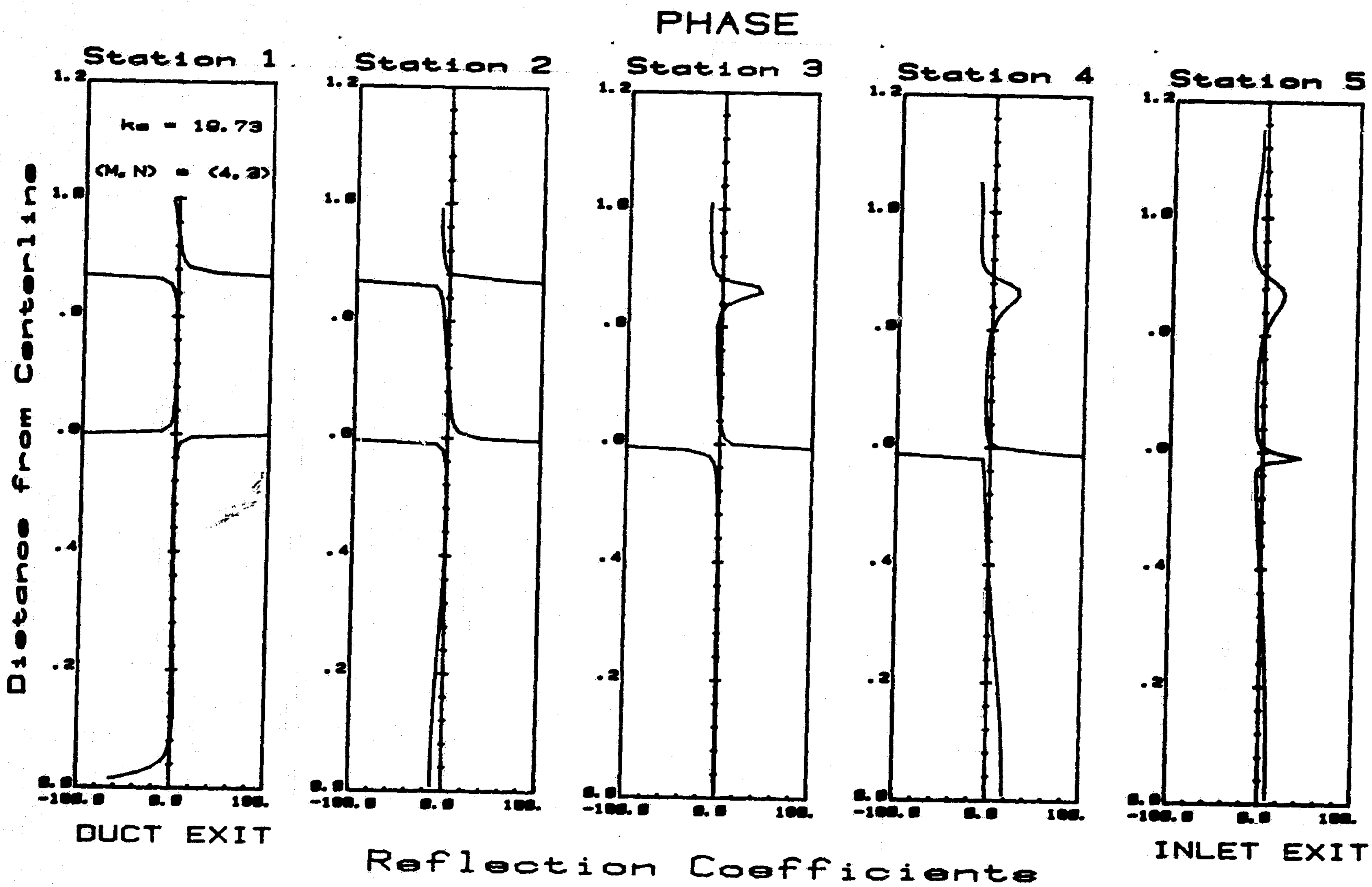

MODULUS
Station 1
Station 2
Station 3
Station 4
Station 5
ka = 10.73
(M, N) = (4, 3)
Distance from Centerline
1.2
1.0
.8
.6
.4
.2
0.0
.5
DUCT EXIT
INLET EXIT
Reflection Coefficients
THICK LIPPED ELLIPTICAL

Fig. 47k



THICK LIPPED ELLIPTICAL

Fig. 471

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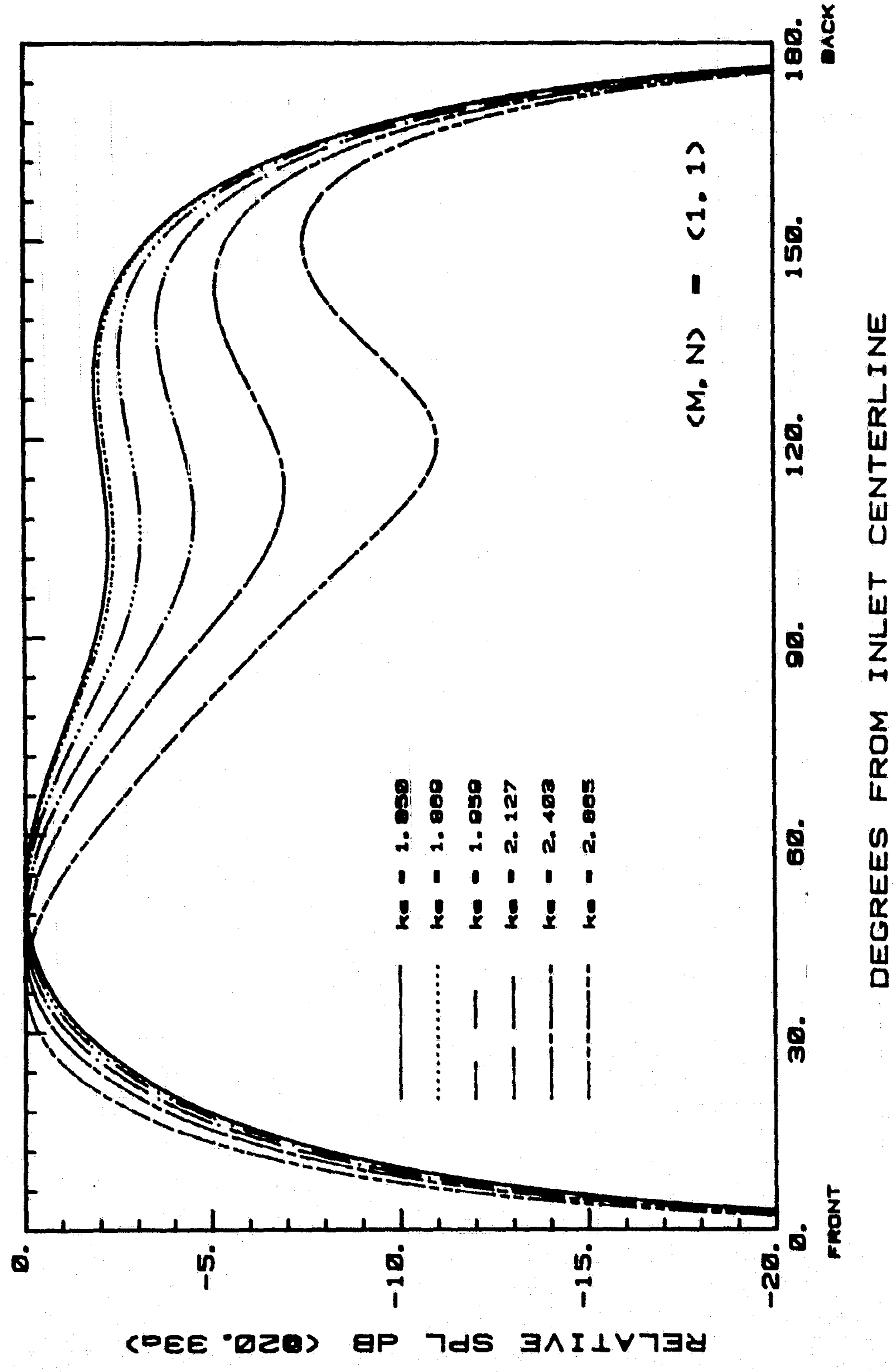
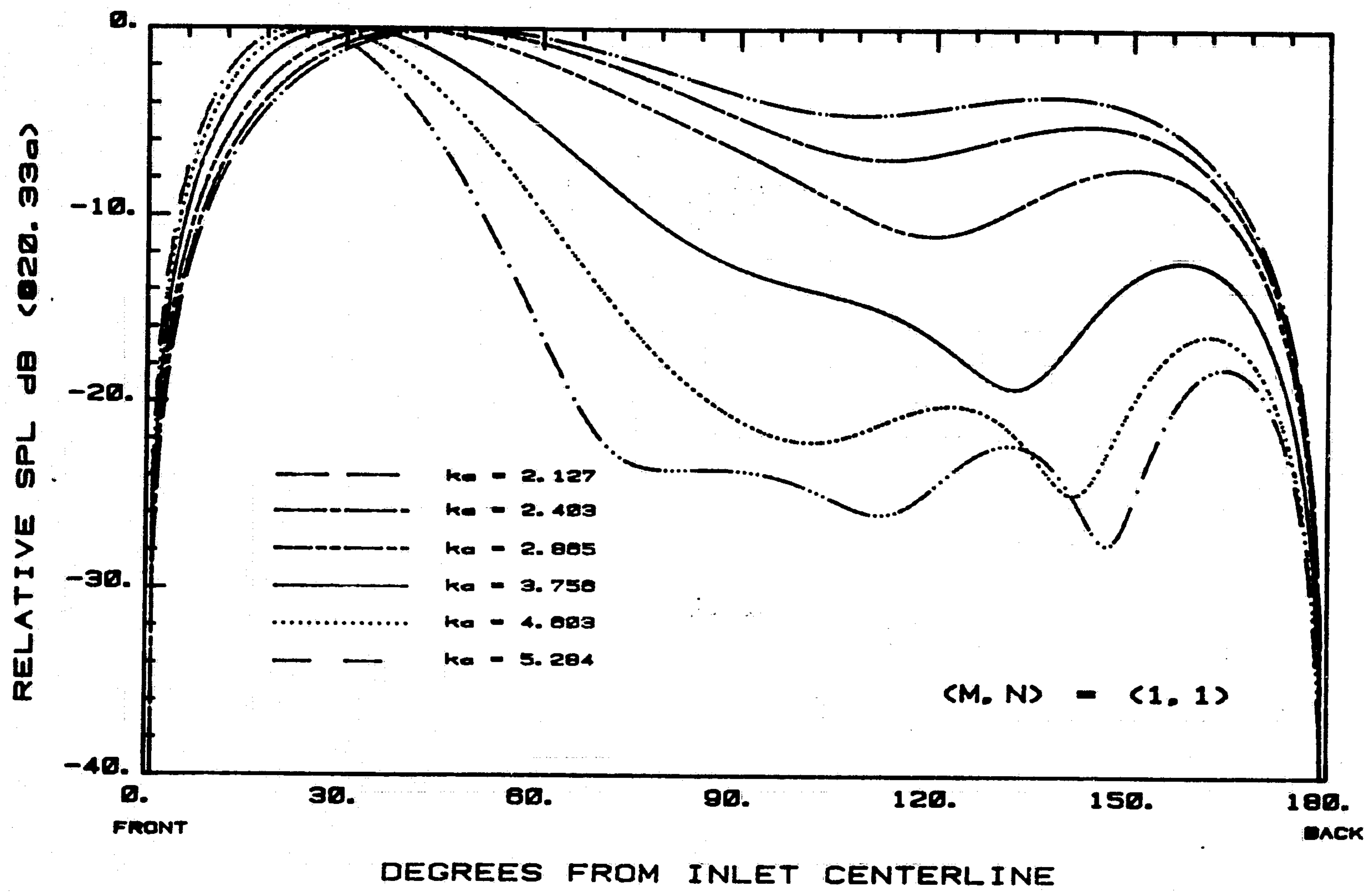


THICK LIPPED ELLIPTICAL INLET

Fig. 48a



THICK LIPPED ELLIPTICAL INLET

Fig. 48b

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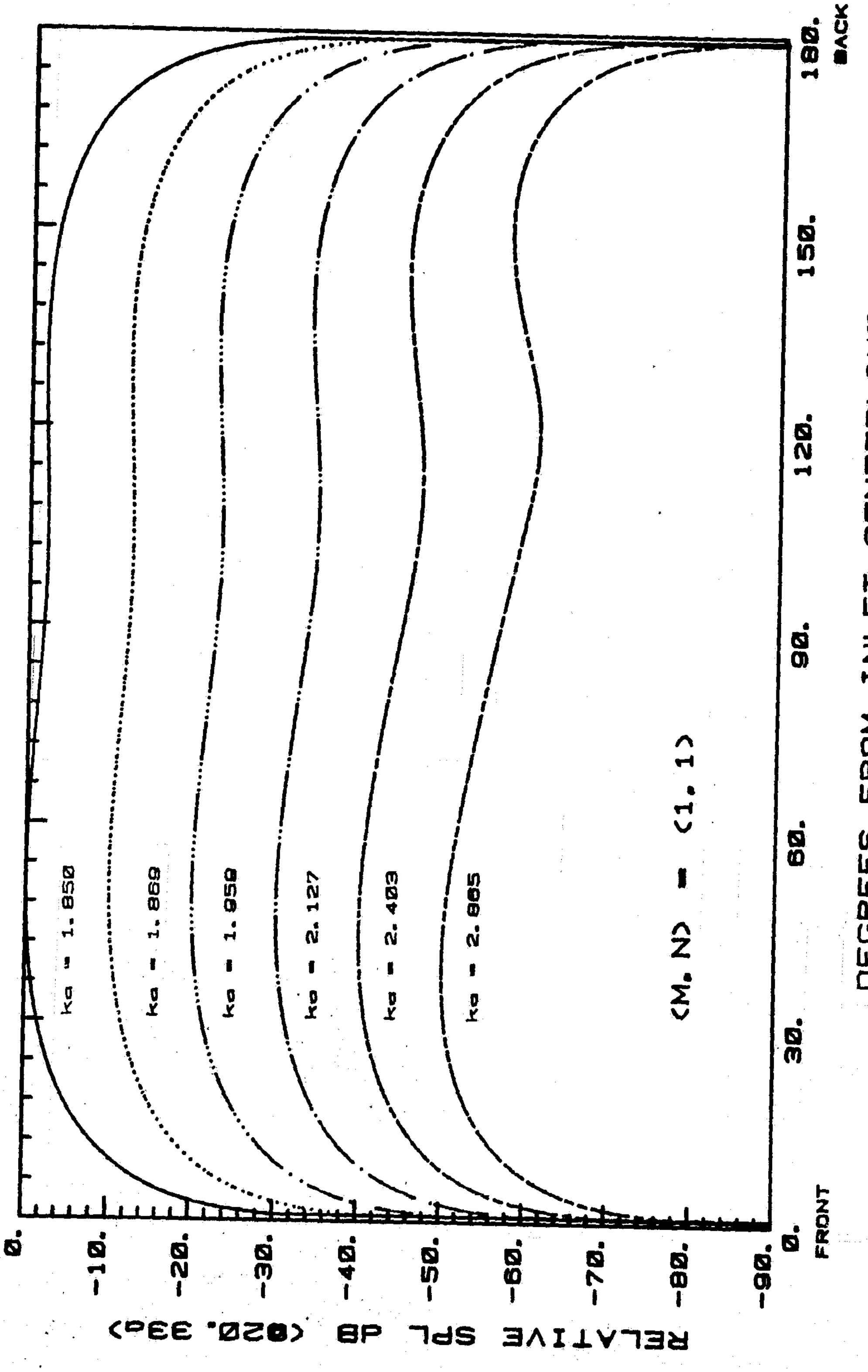

THICK LIPPED ELLIPTICAL INLET

Fig. 48c

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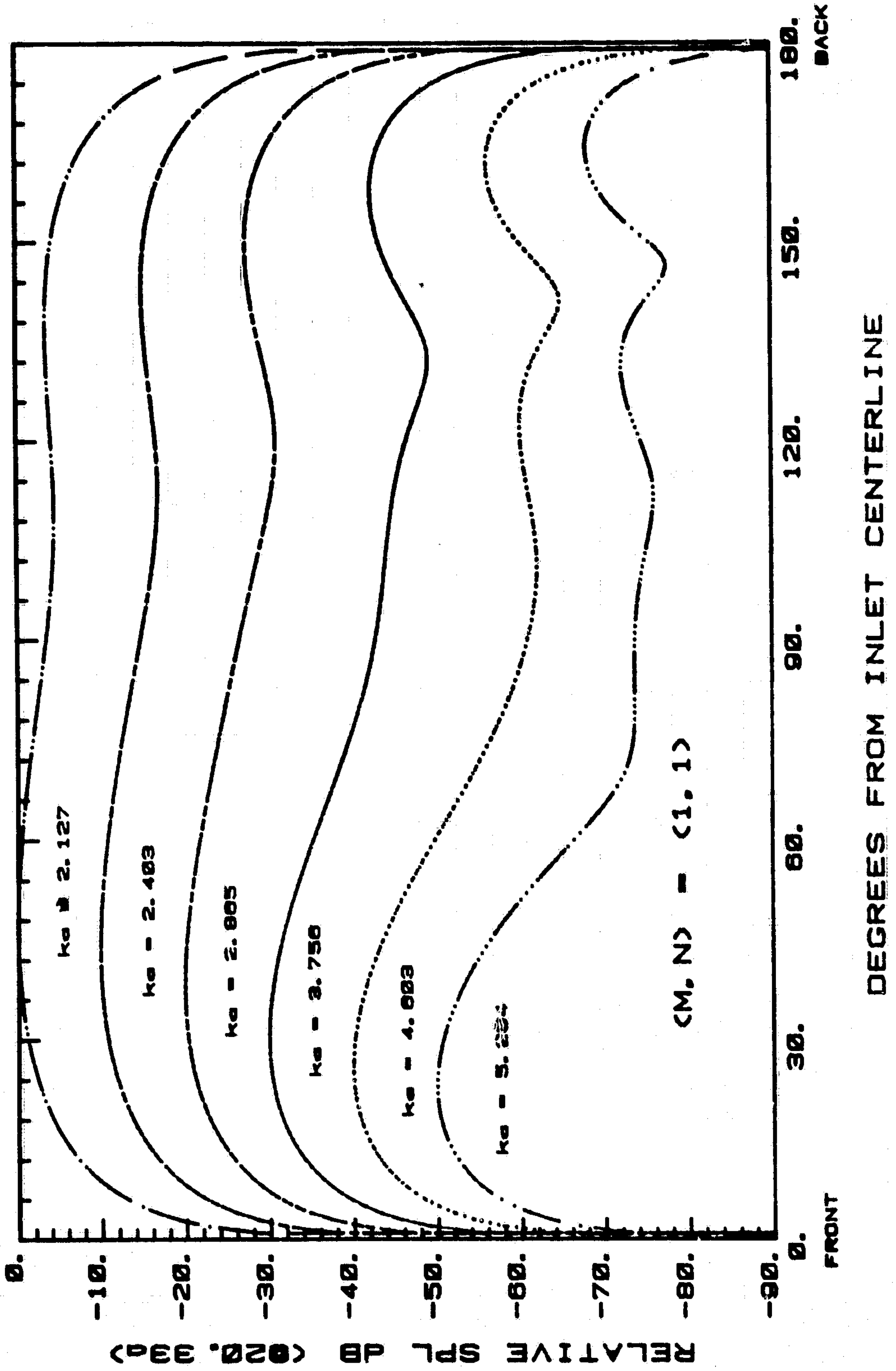

THICK LIPPED ELLIPTICAL INLET

Fig. 48d

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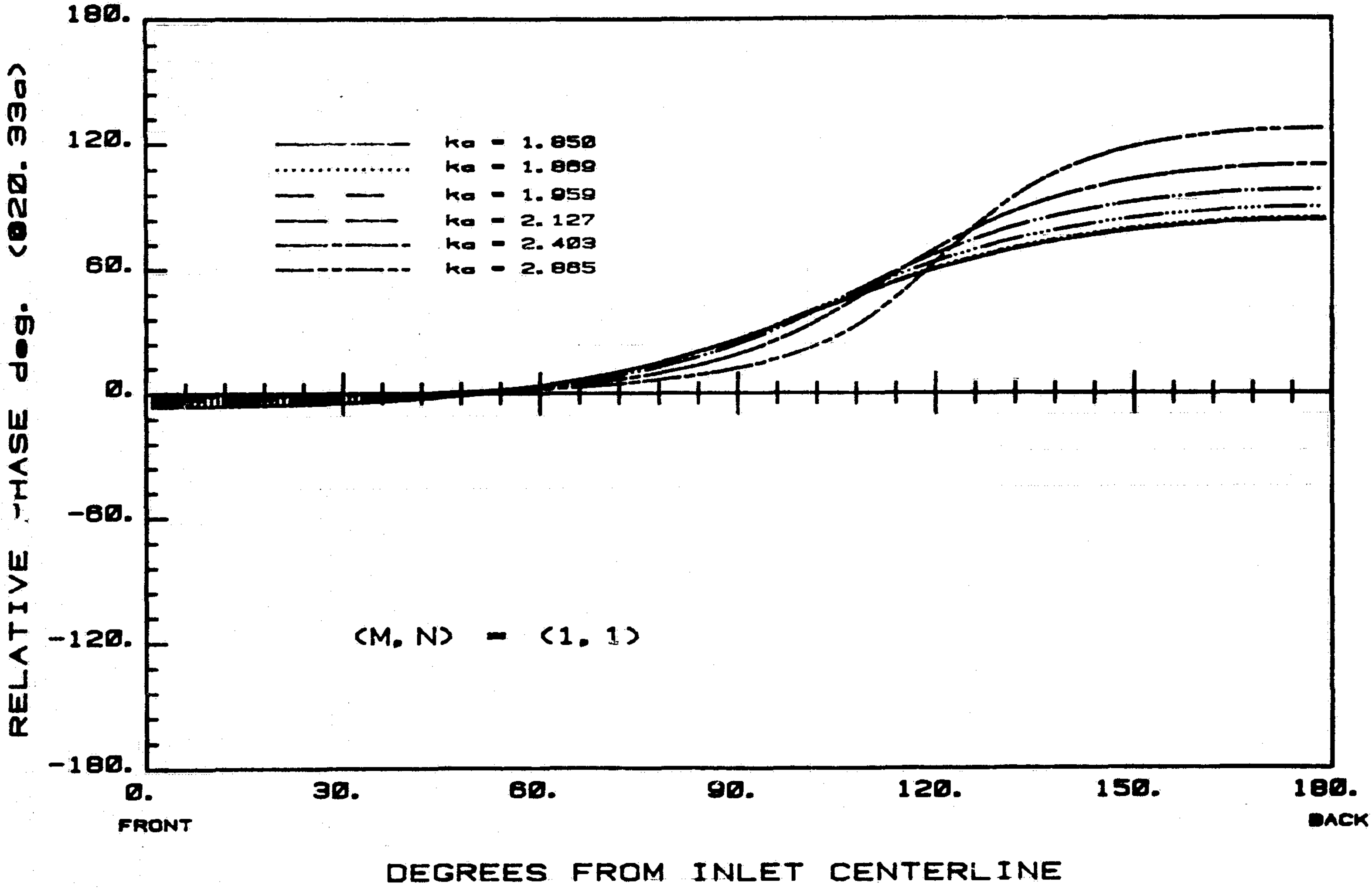
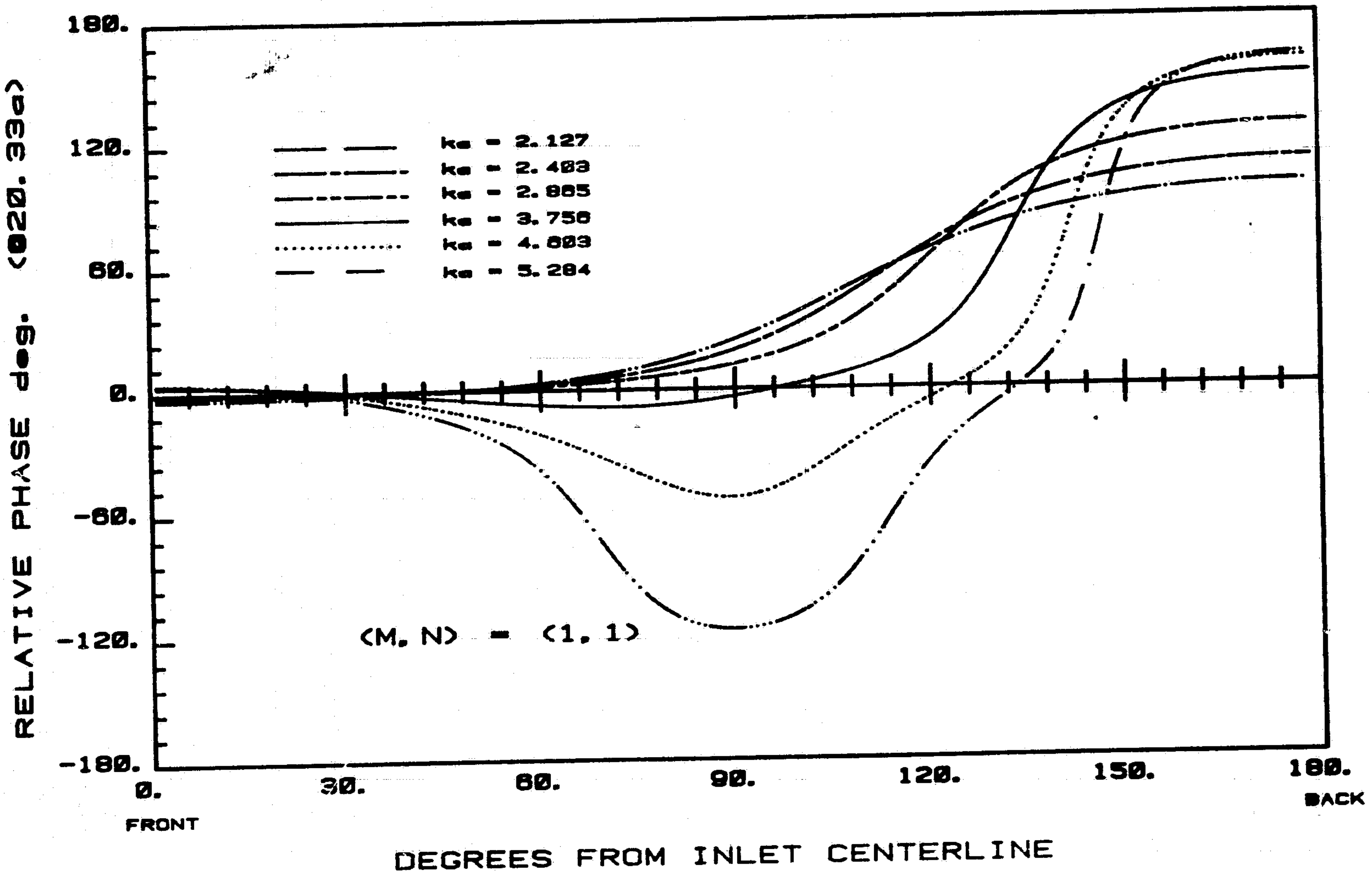


THICK LIPPED ELLIPTICAL INLET

Fig. 48e



THICK LIPPED ELLIPTICAL INLET

Fig. 48f

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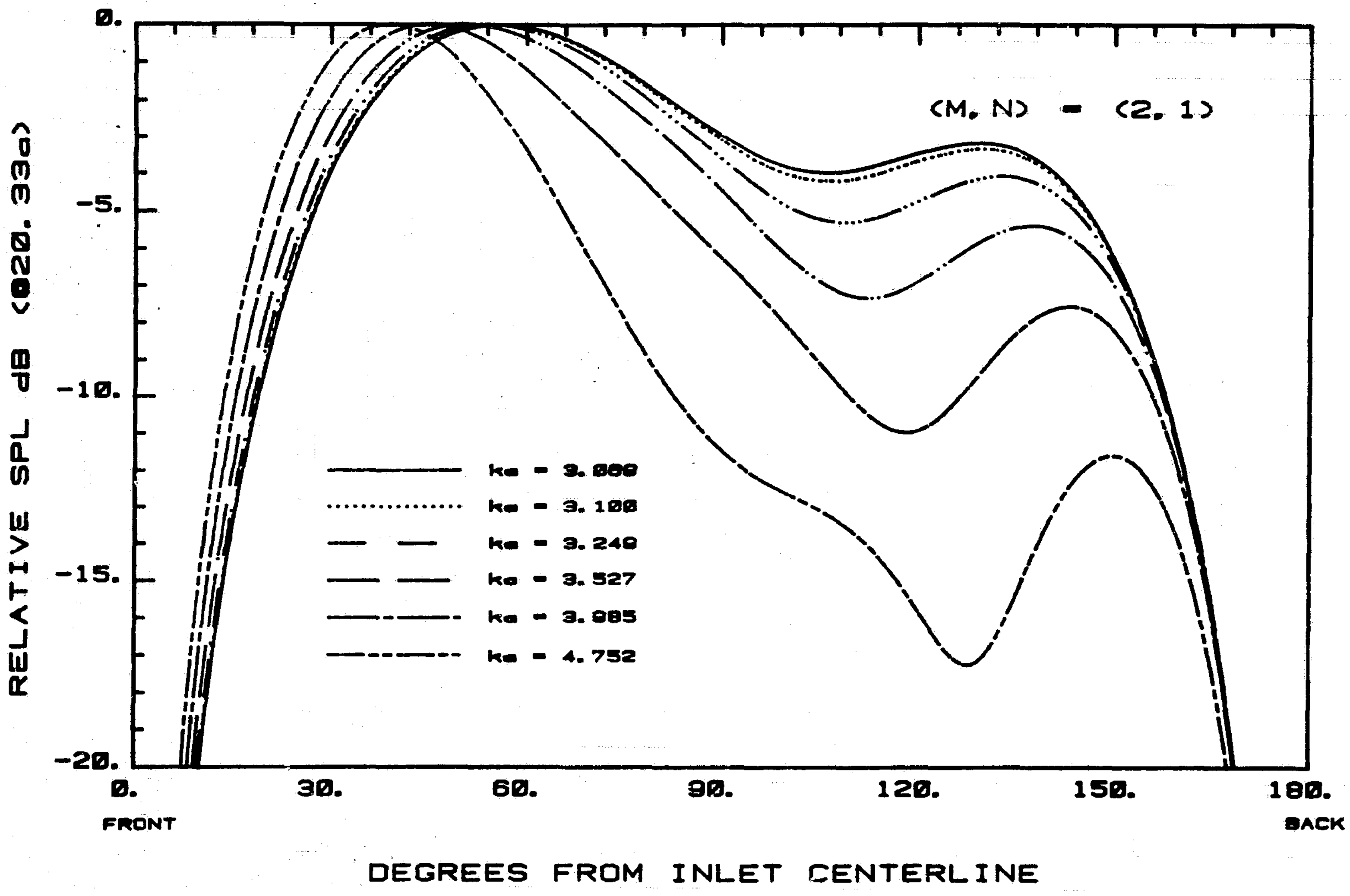
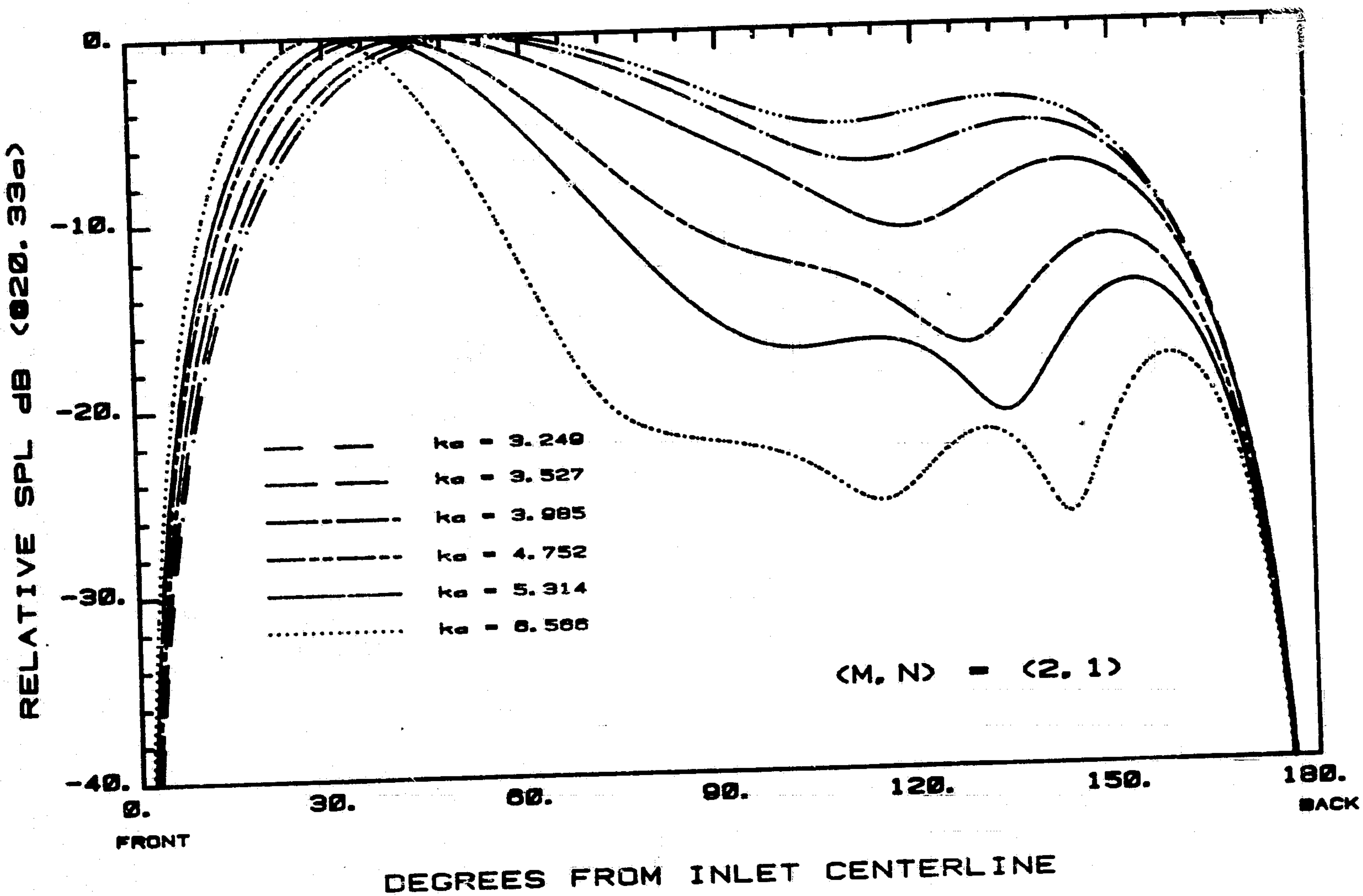


THICK LIPPED ELLIPTICAL INLET

Fig. 49a



THICK LIPPED ELLIPTICAL INLET

Fig. 49b

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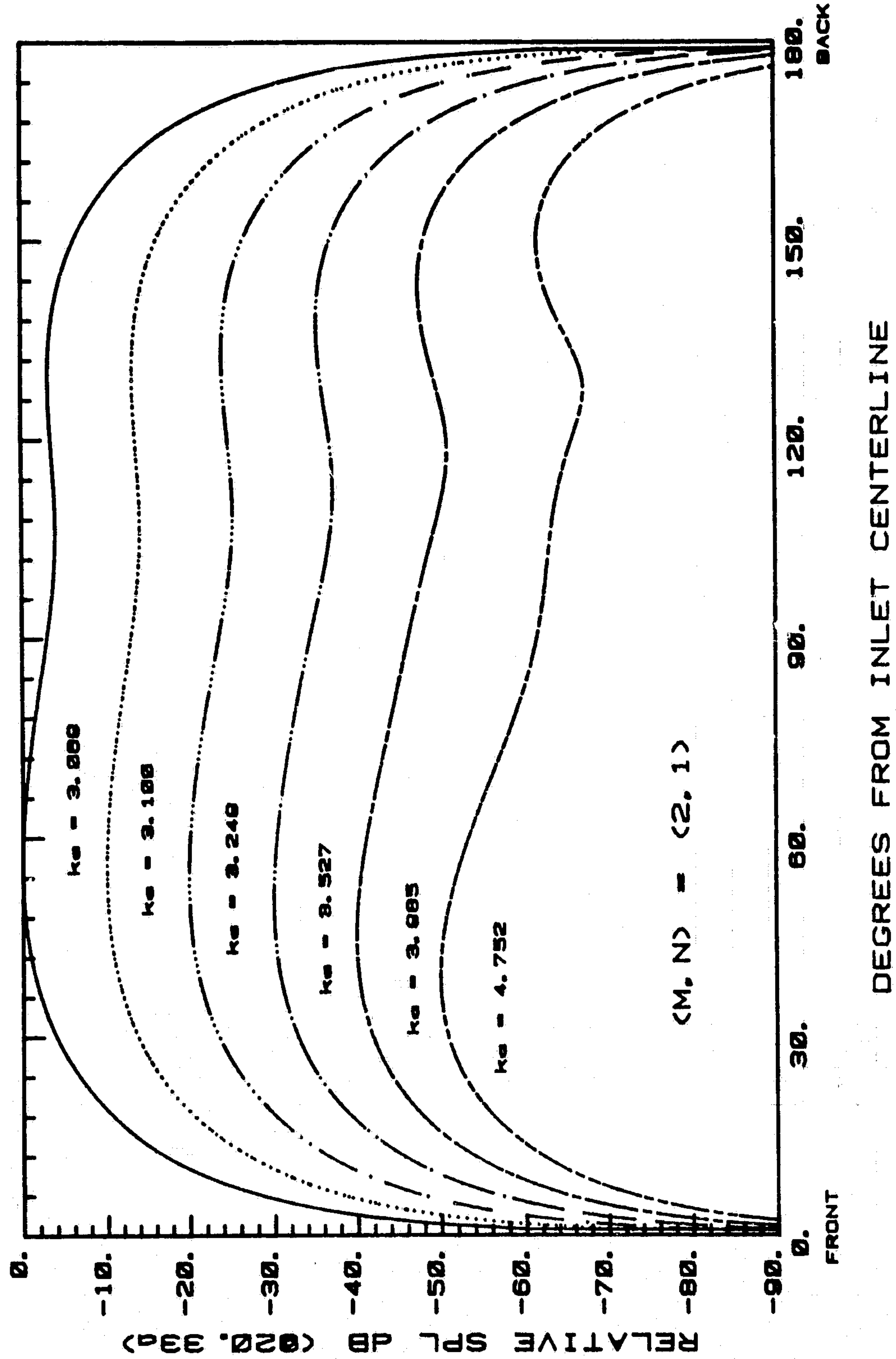
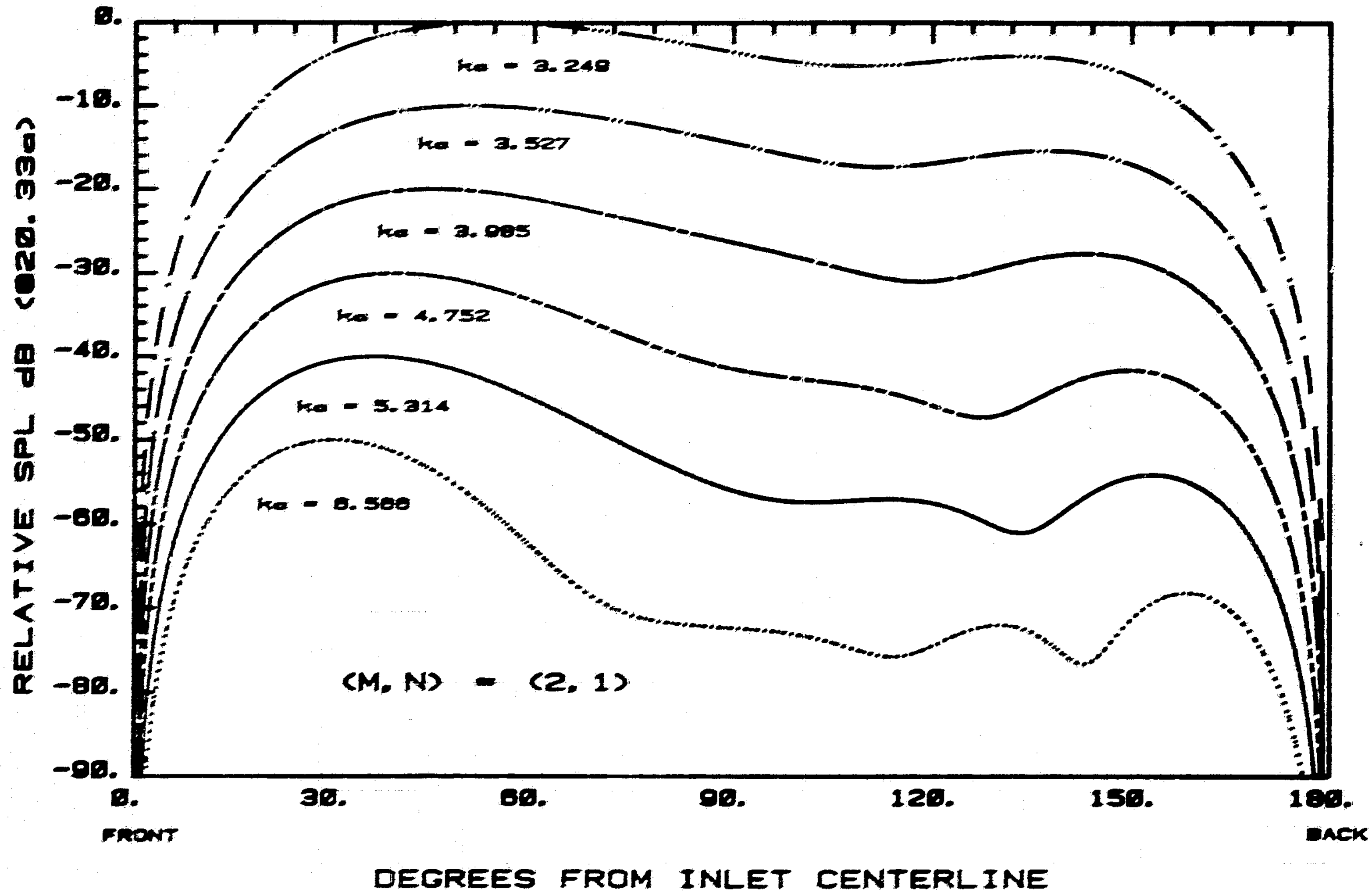


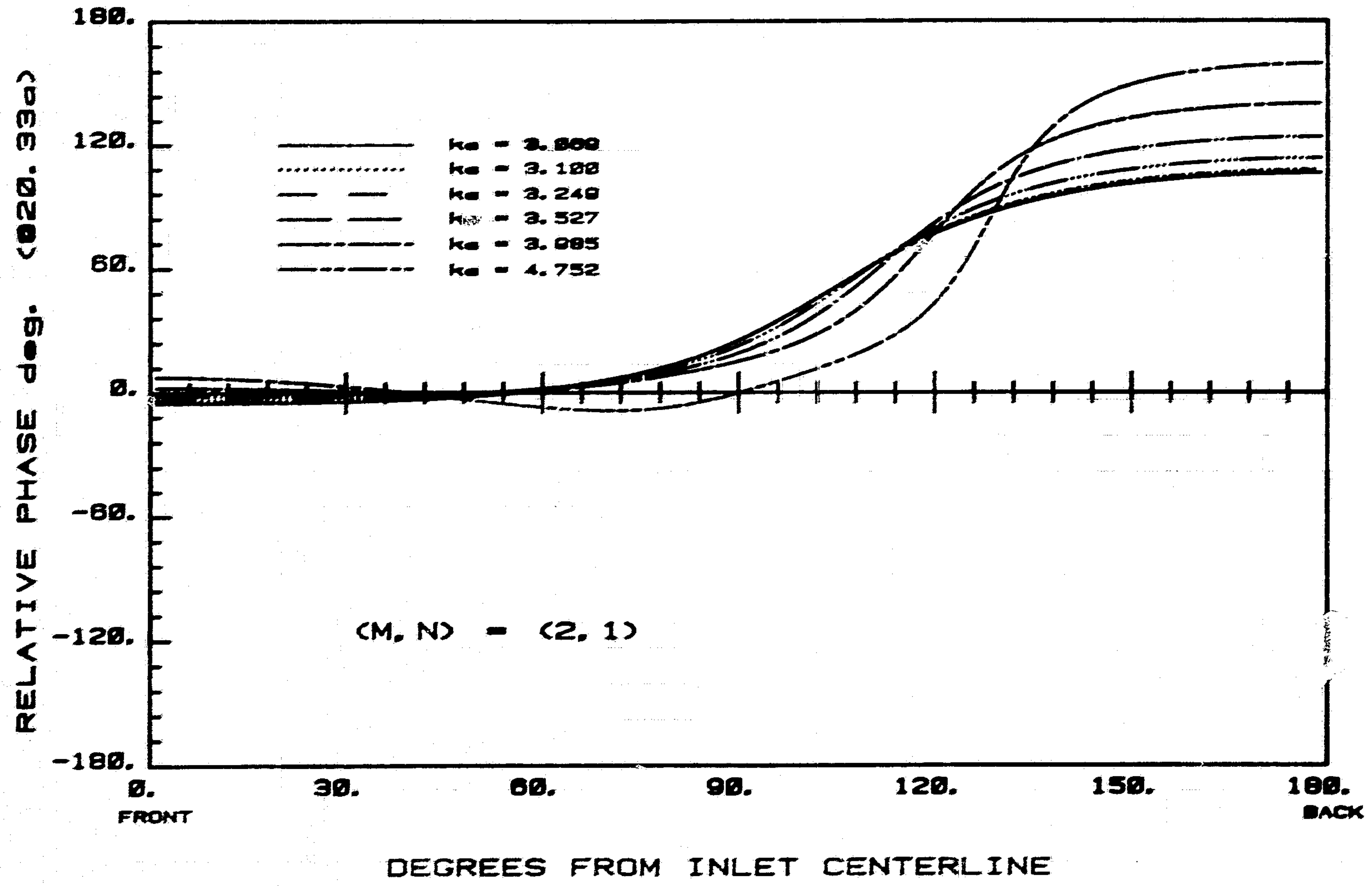
THICK LIPPED ELLIPTICAL INLET

Fig. 49c



THICK LIPPED ELLIPTICAL INLET

Fig. 49d



THICK LIPPED ELLIPTICAL INLET

Fig. 49e

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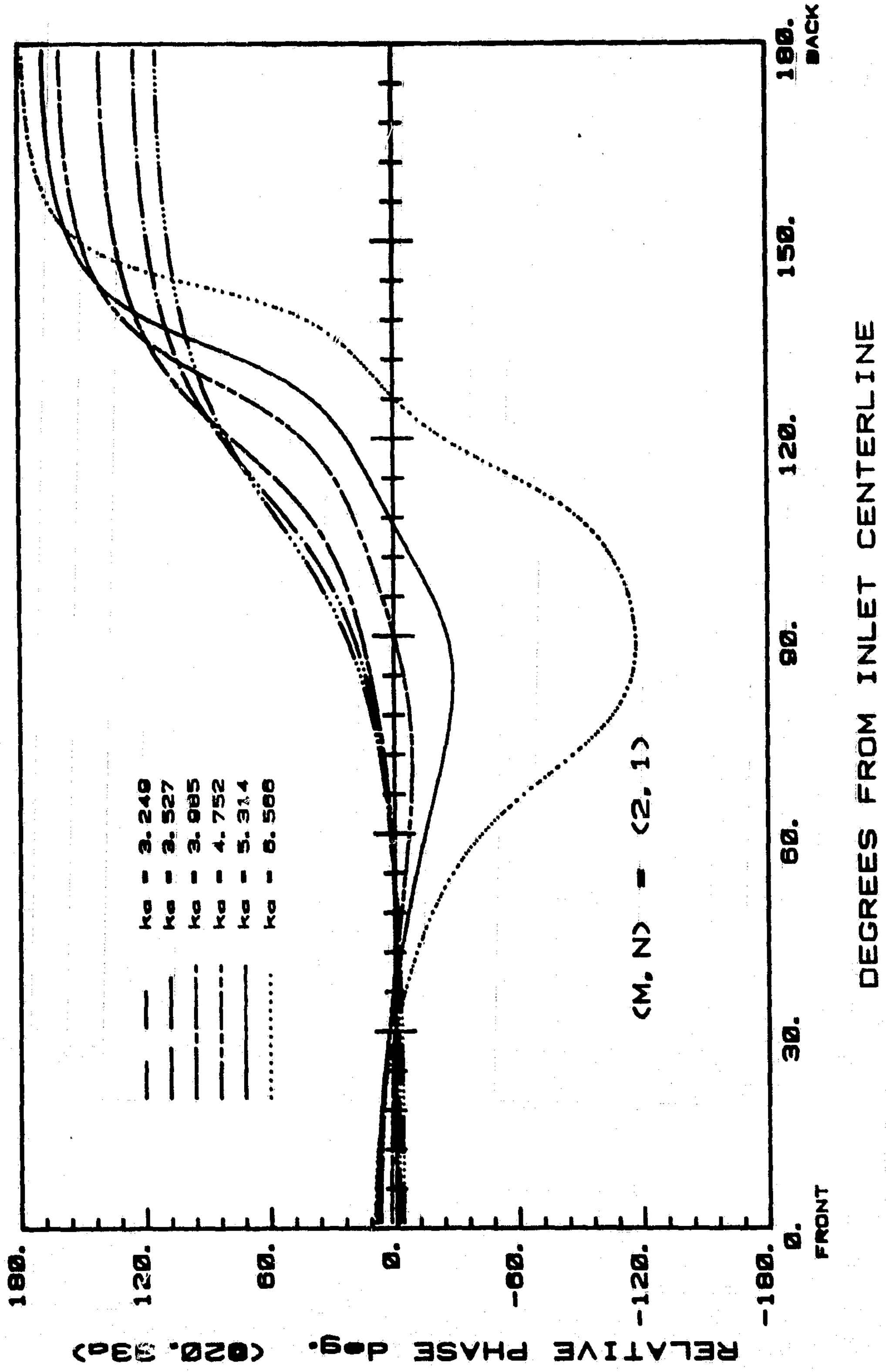

THICK LIPPED ELLIPTICAL INLET

Fig. 49f

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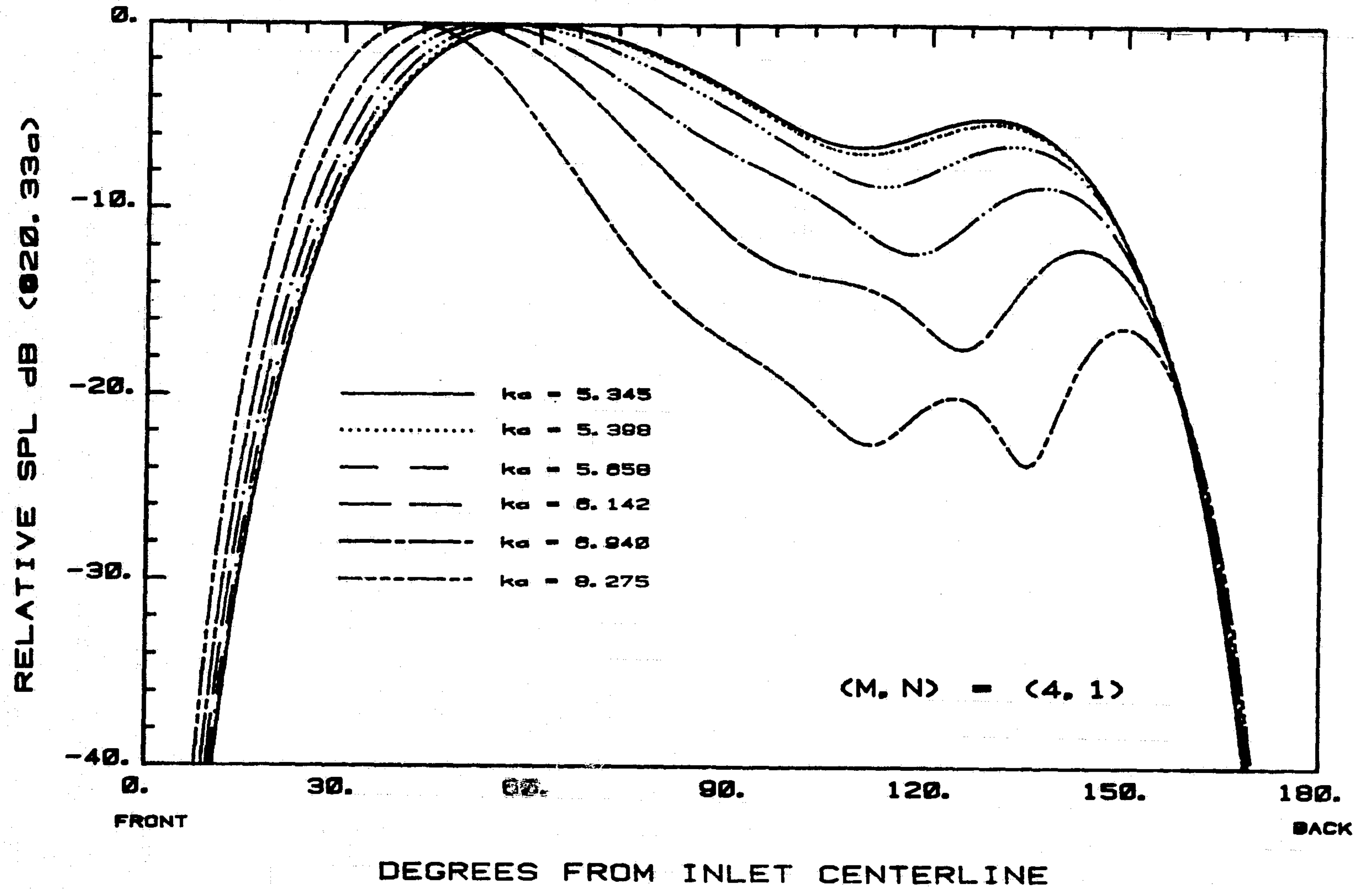
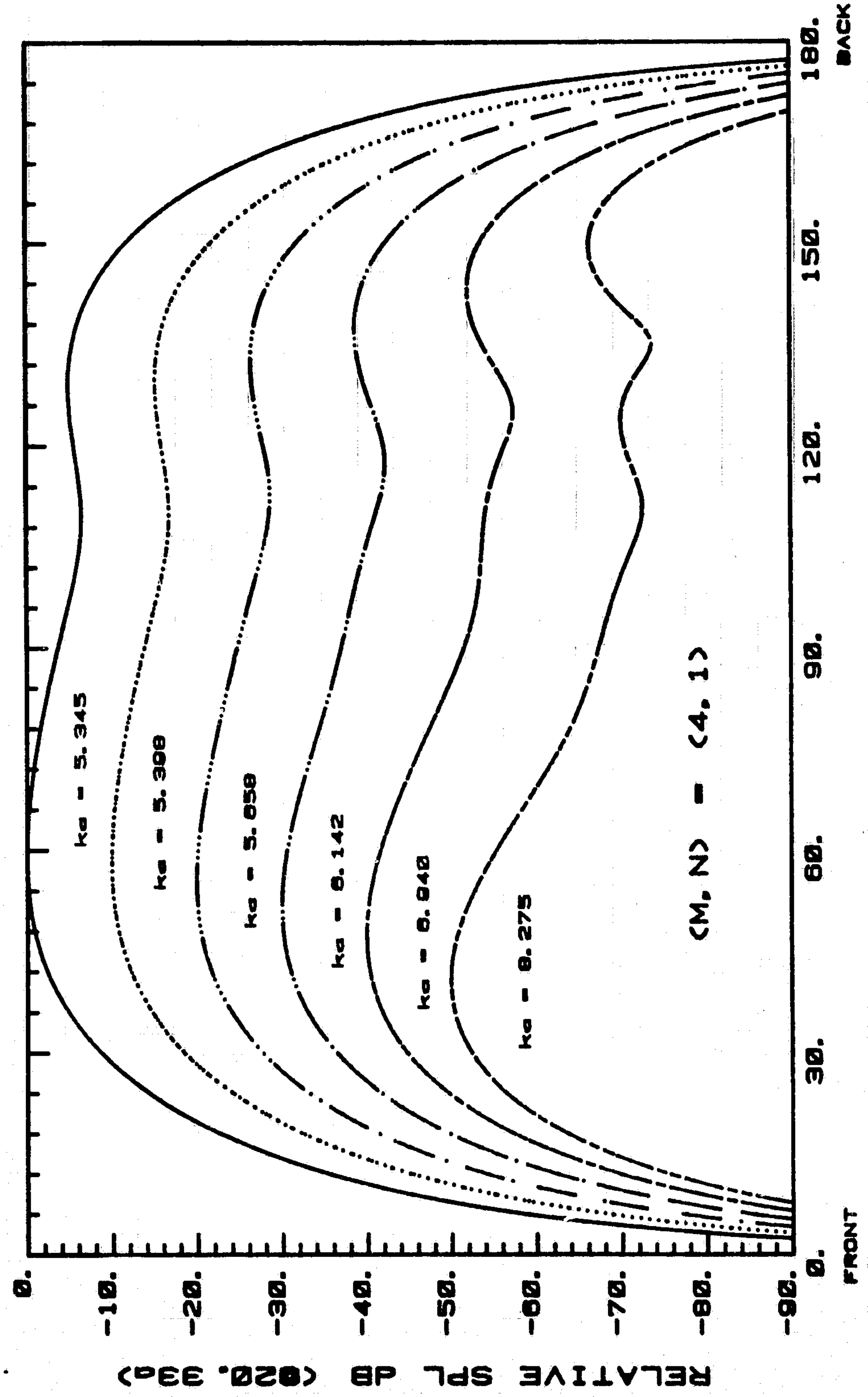


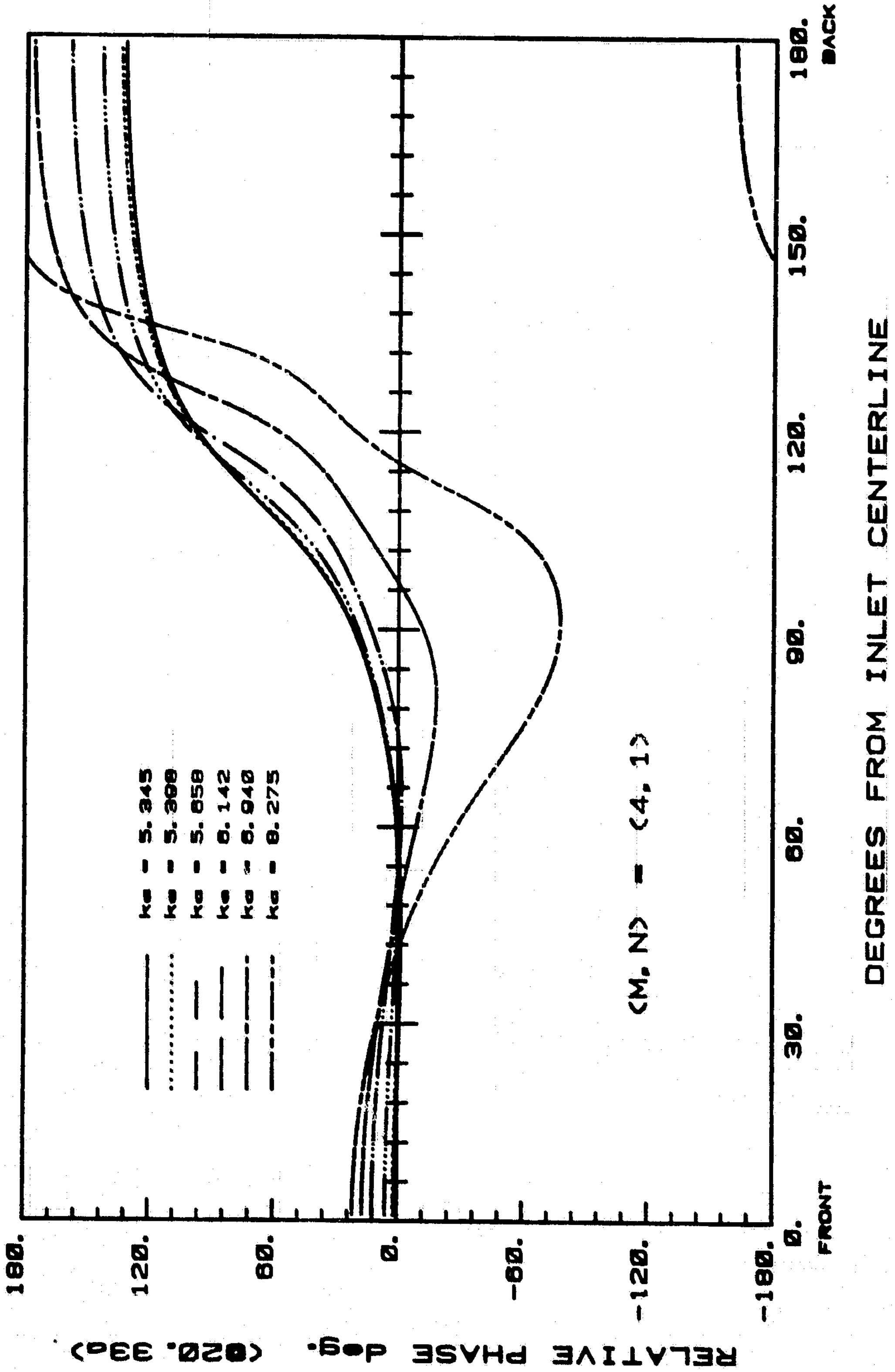
THICK LIPPED ELLIPTICAL INLET

Fig. 50a



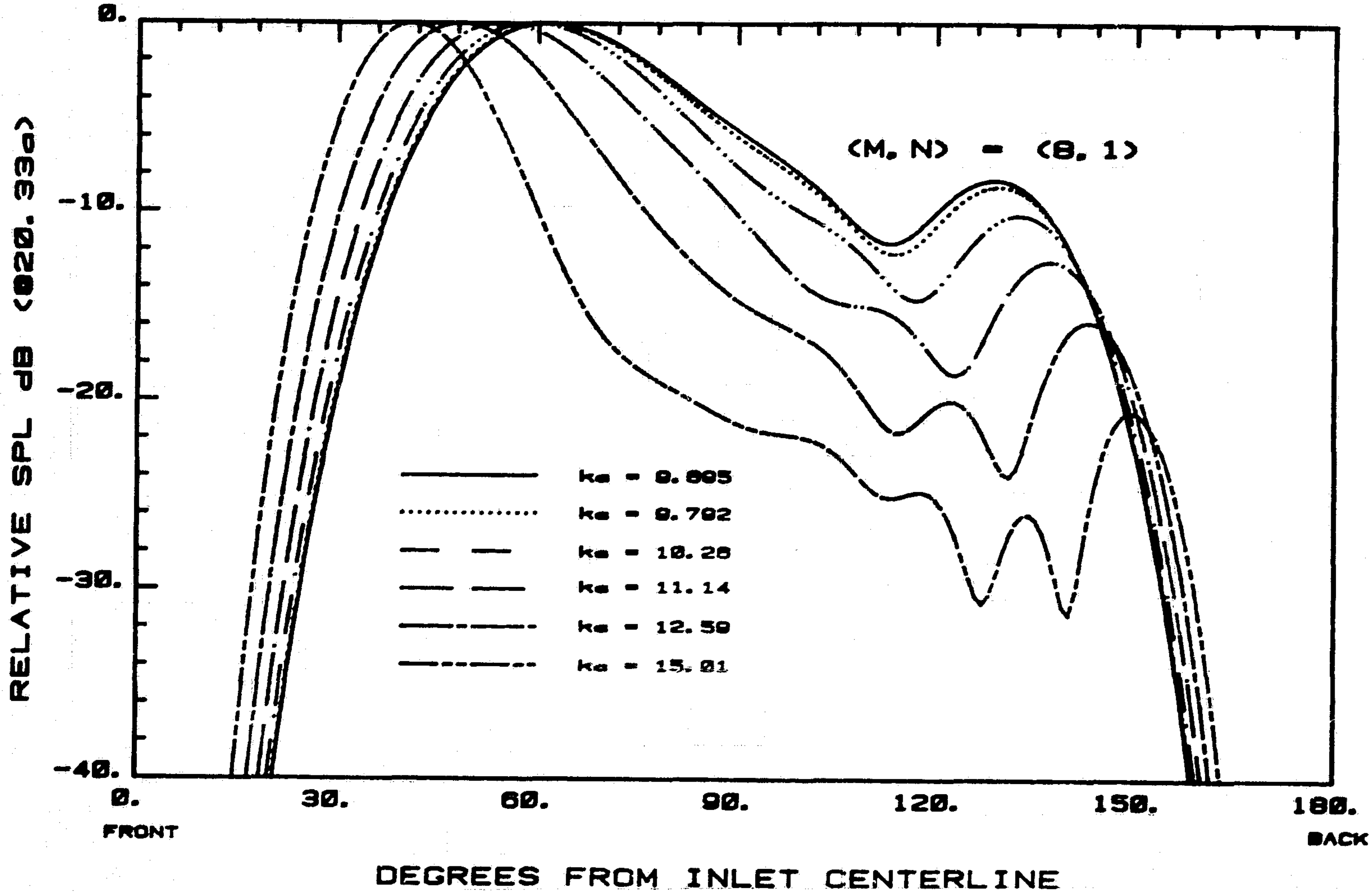
THICK LIPPED ELLIPTICAL INLET

Fig. 50b



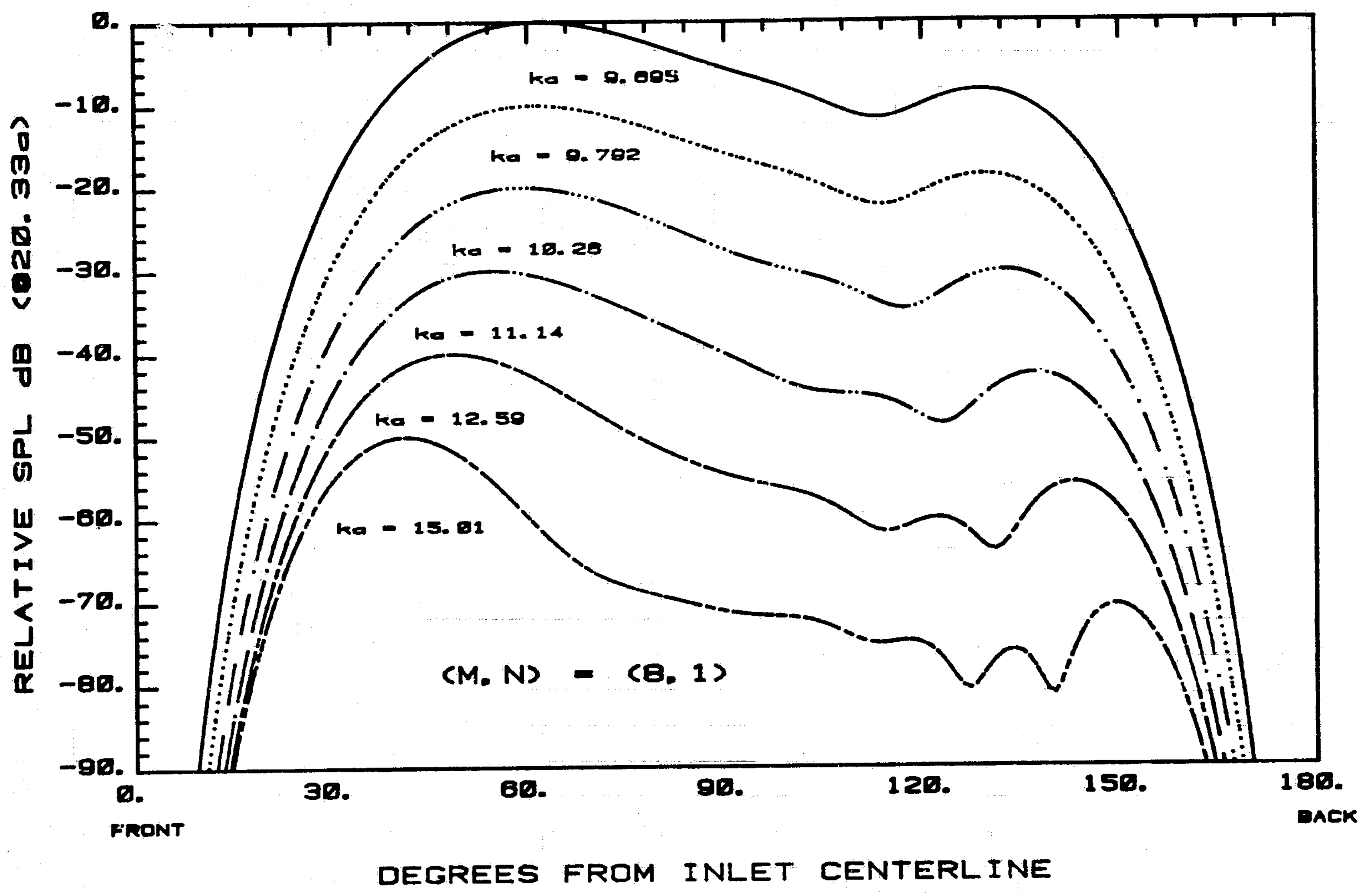
THICK LIPPED ELLIPTICAL INLET

Fig. 50c



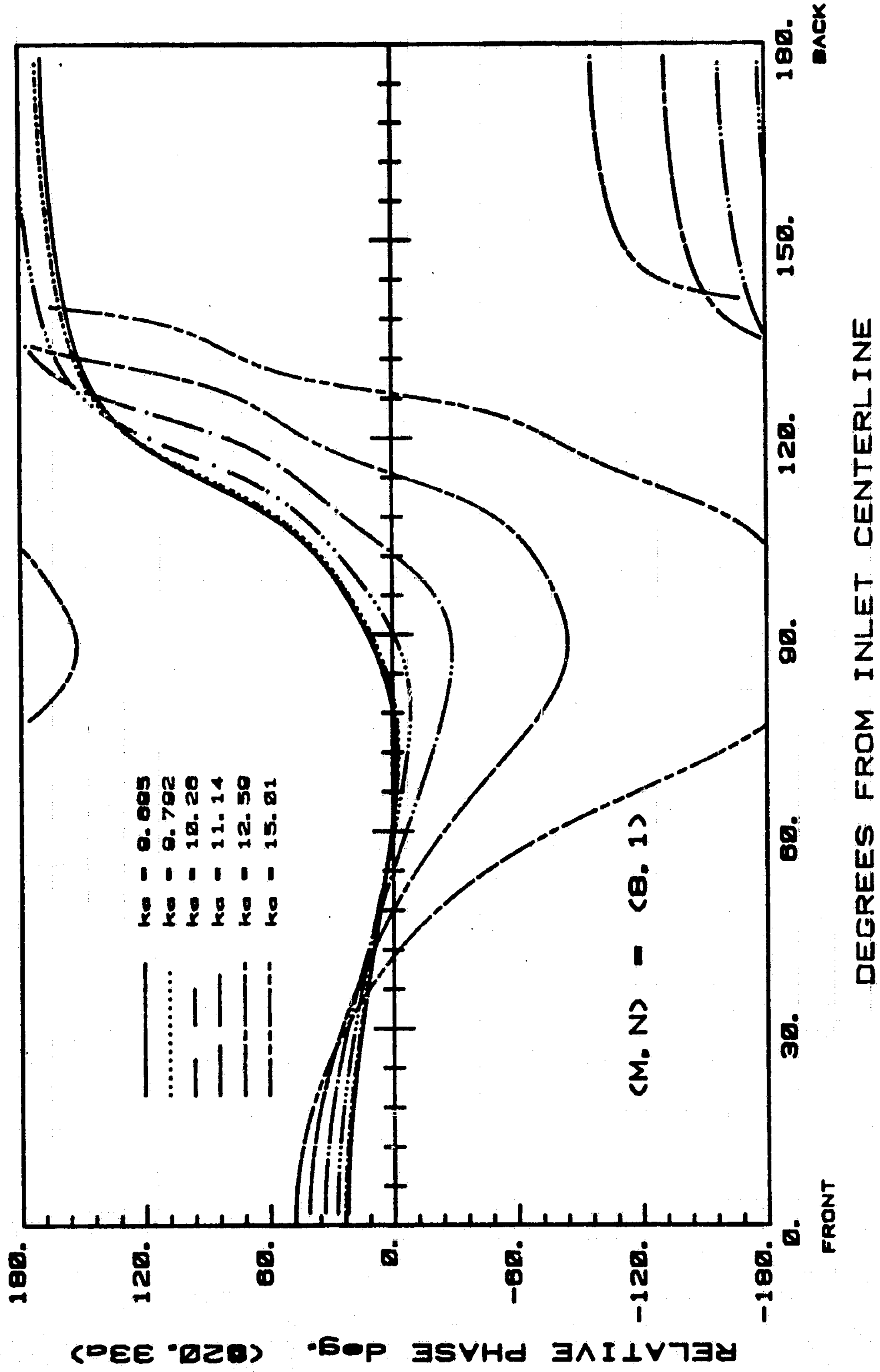
THICK LIPPED ELLIPTICAL INLET

Fig. 51a



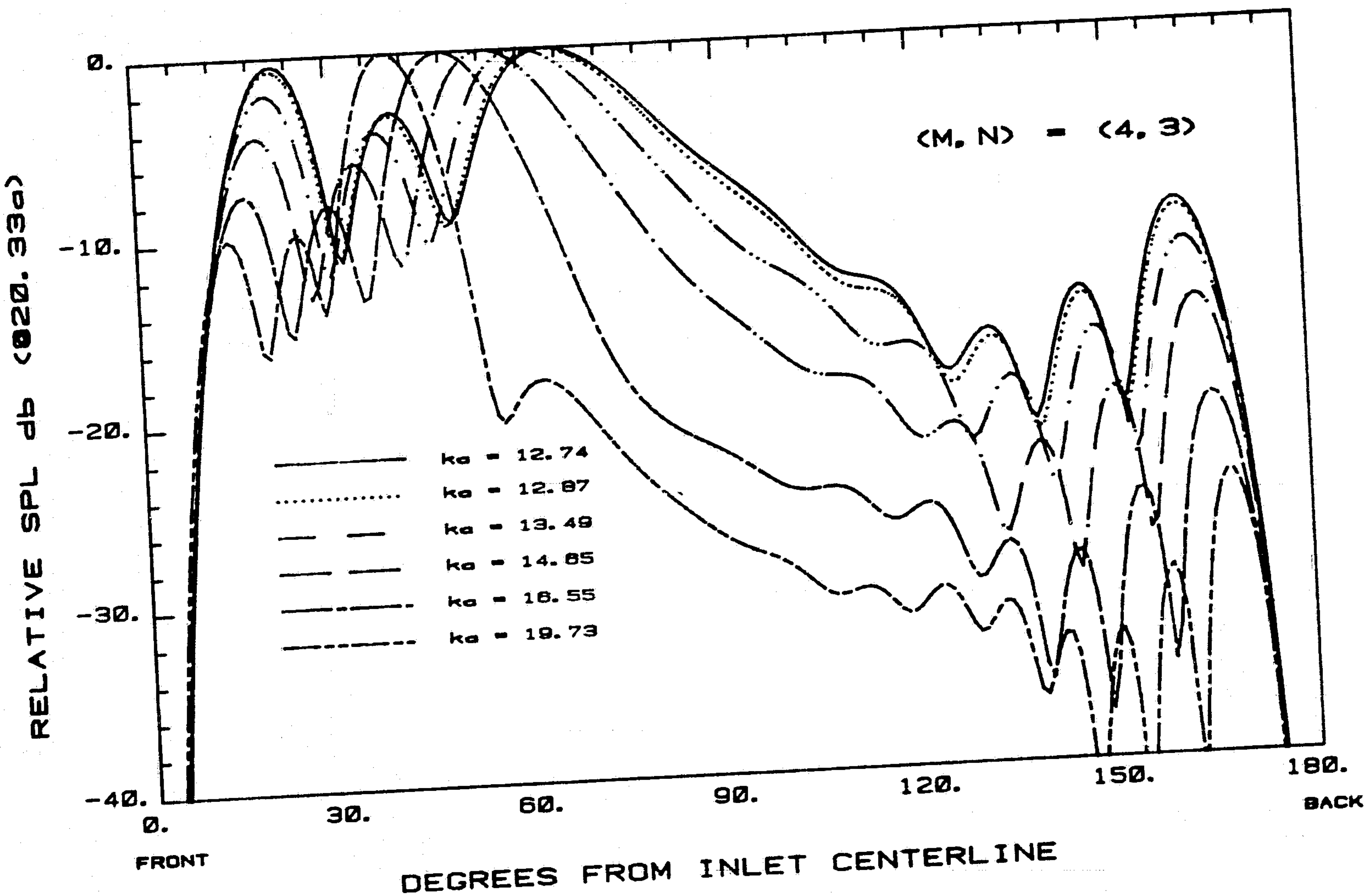
THICK LIPPED ELLIPTICAL INLET

Fig. 51b



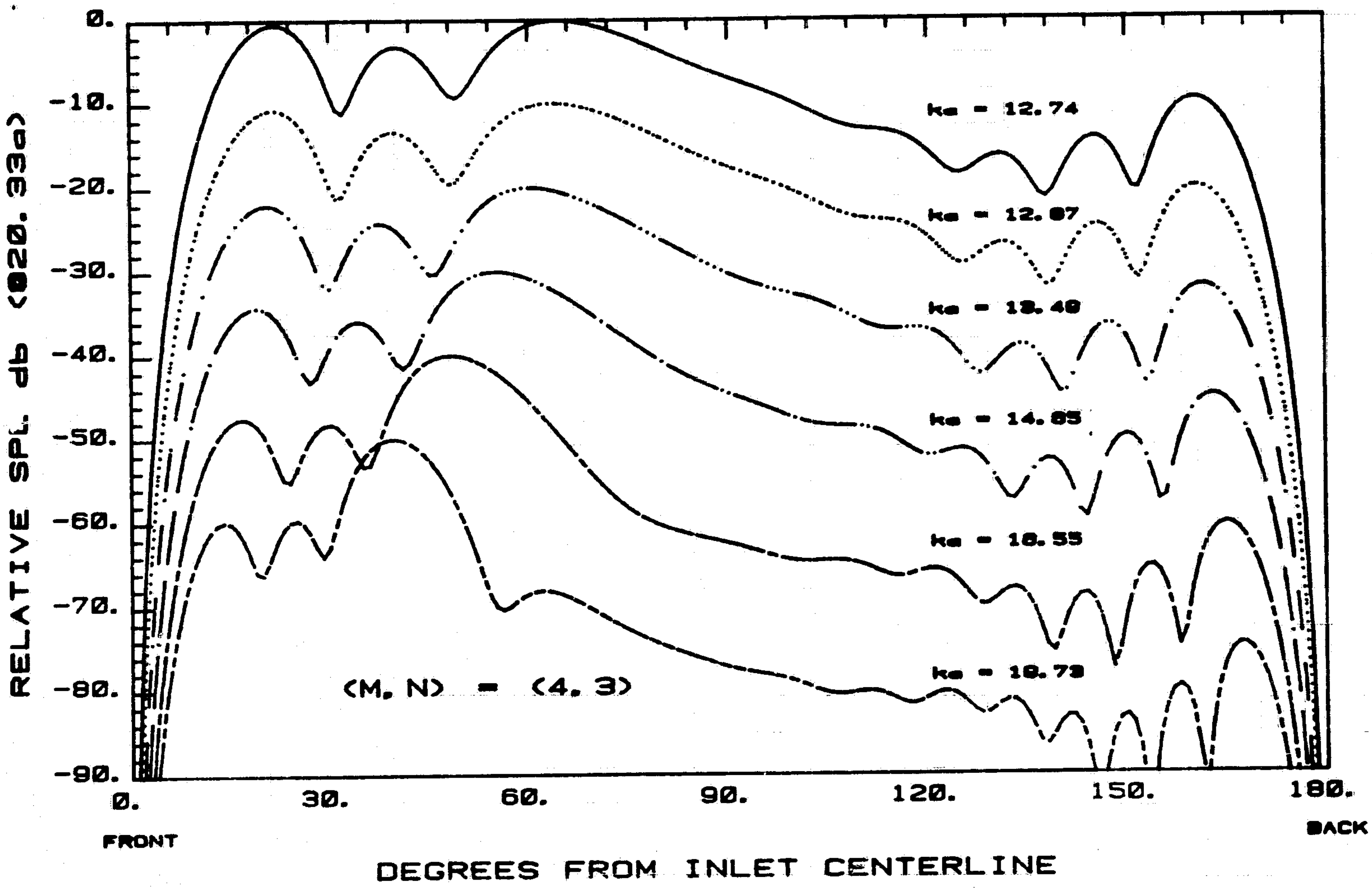
THICK LIPPED ELLIPTICAL INLET

Fig. 51c



THICK LIPPED ELLIPTICAL INLET

Fig. 52a



THICK LIPPED ELLIPTICAL INLET

Fig. 52b

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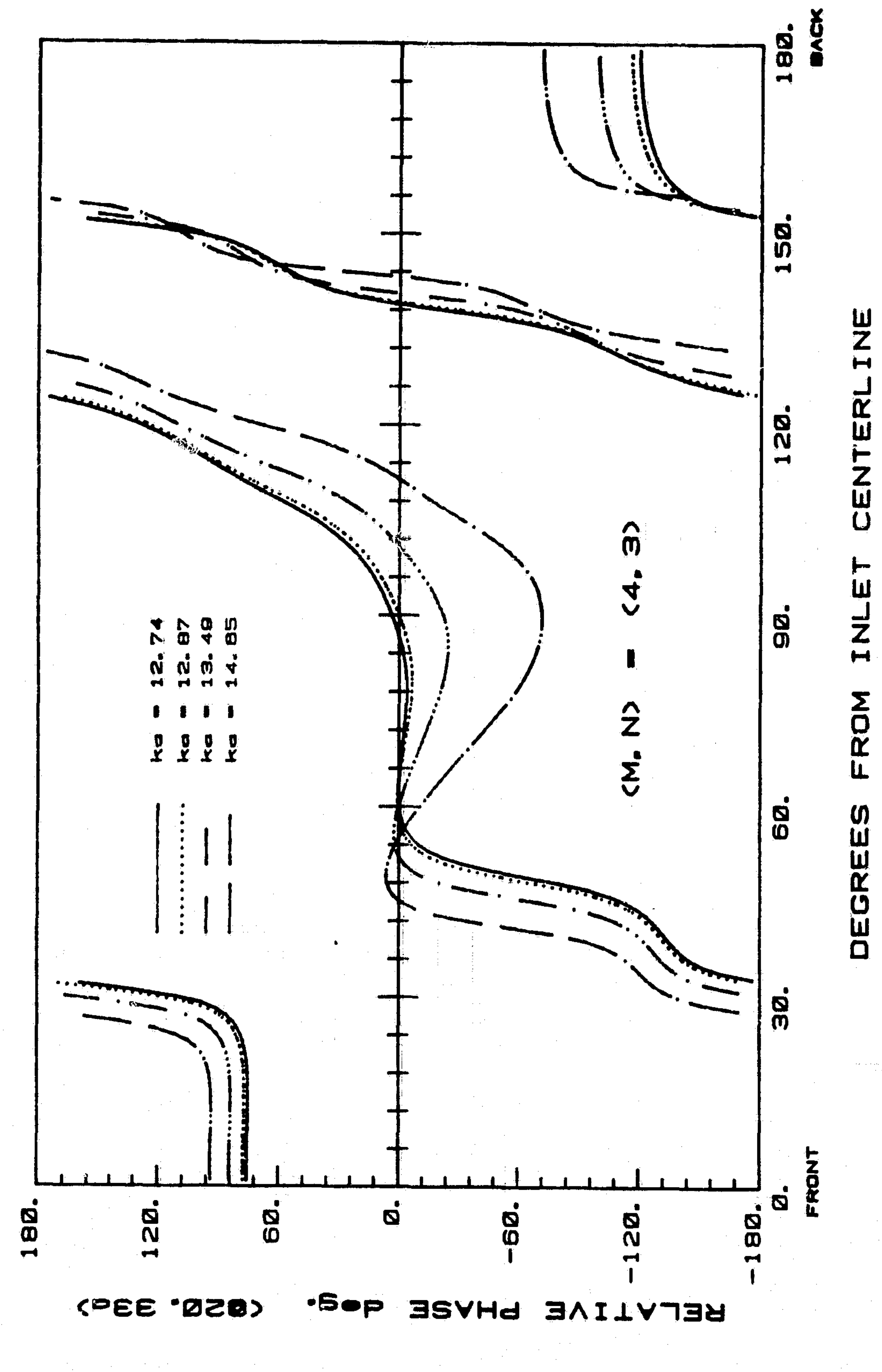
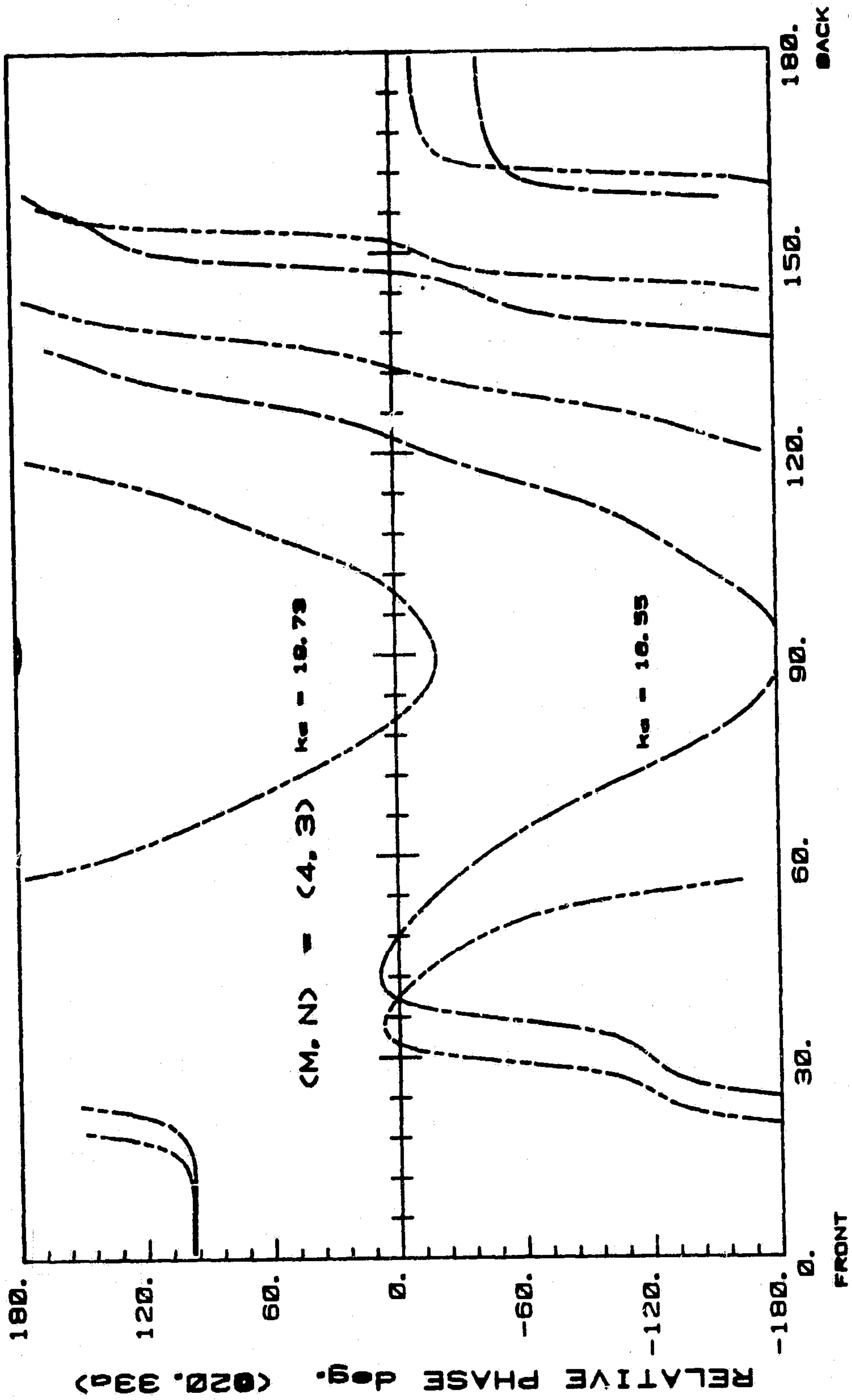


THICK LIPPED ELLIPTICAL INLET

Fig. 52c



THICK LIPPED ELLIPTICAL INLET

Fig. 52d

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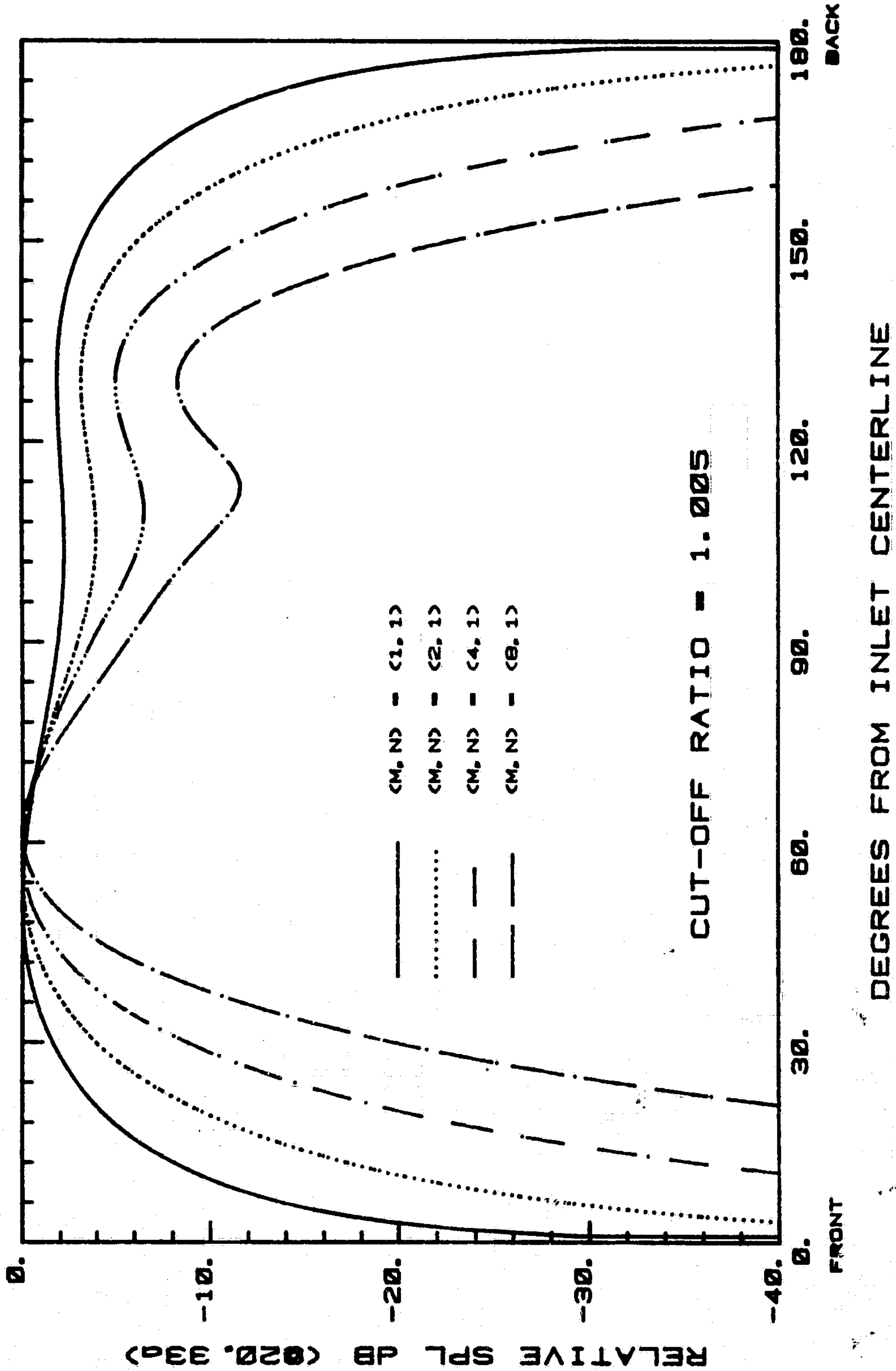
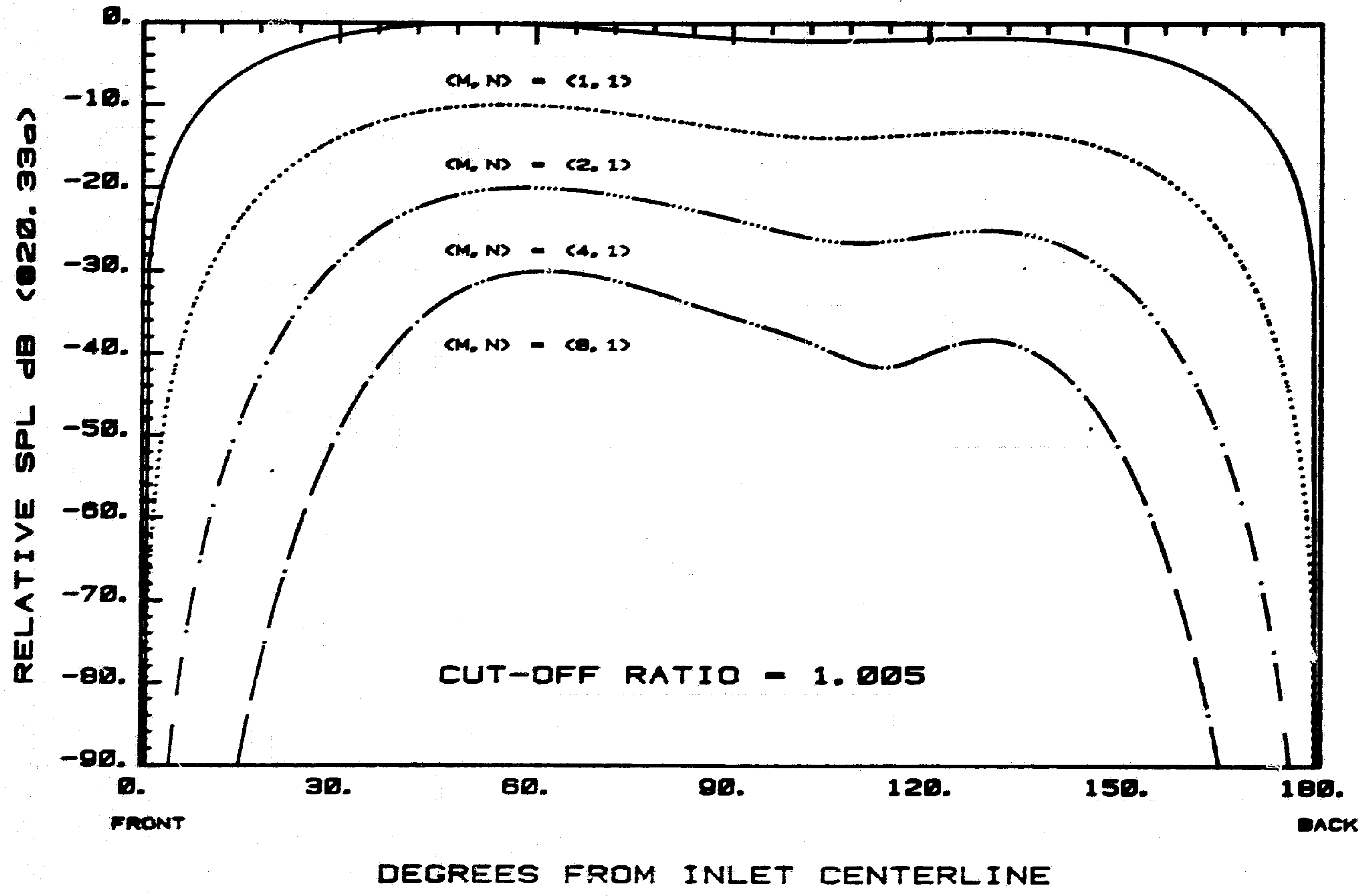


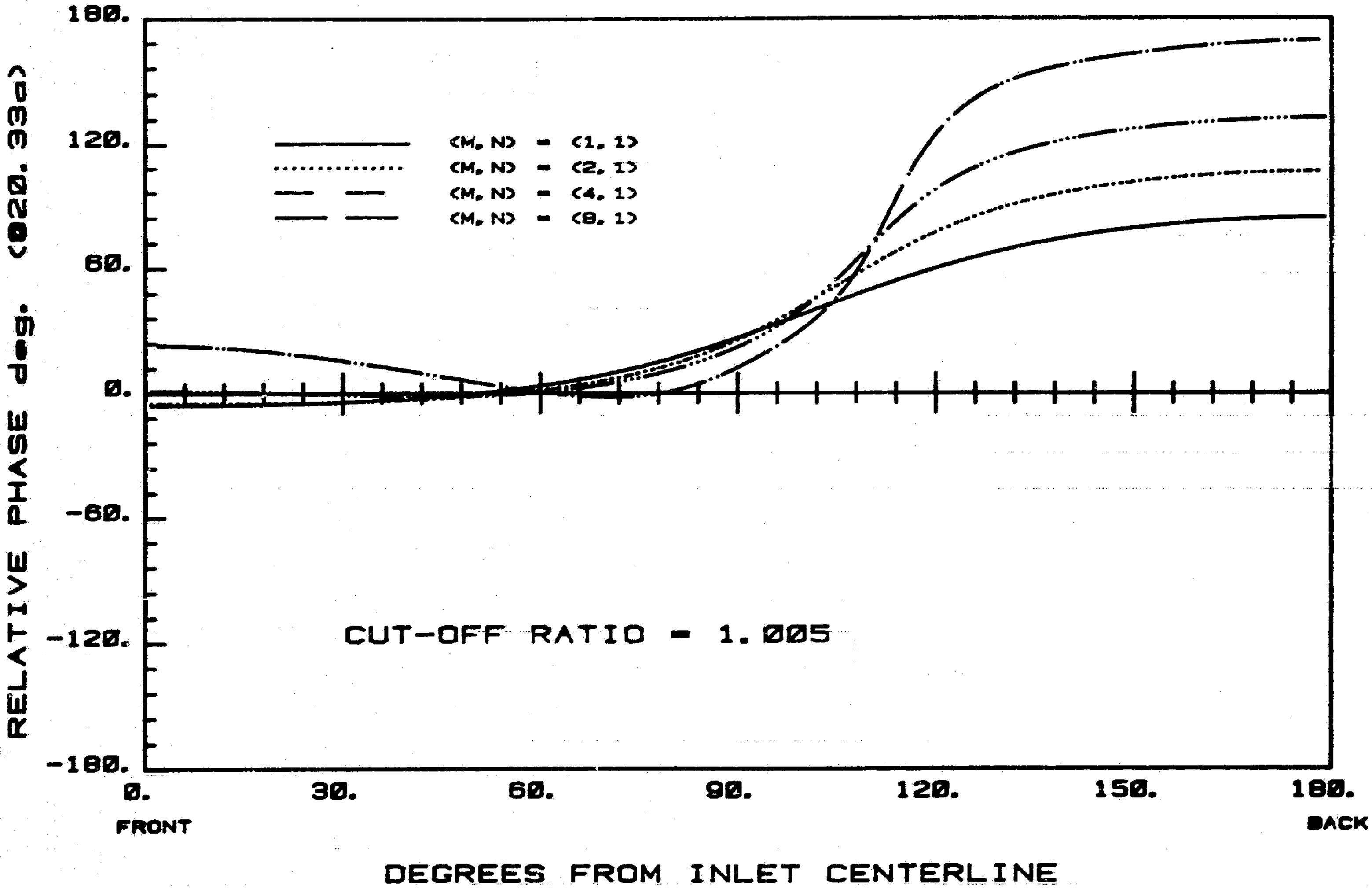
THICK LIPPED ELLIPTICAL INLET

Fig. 53a



THICK LIPPED ELLIPTICAL INLET

Fig. 53b



THICK LIPPED ELLIPTICAL INLET

Fig. 53c

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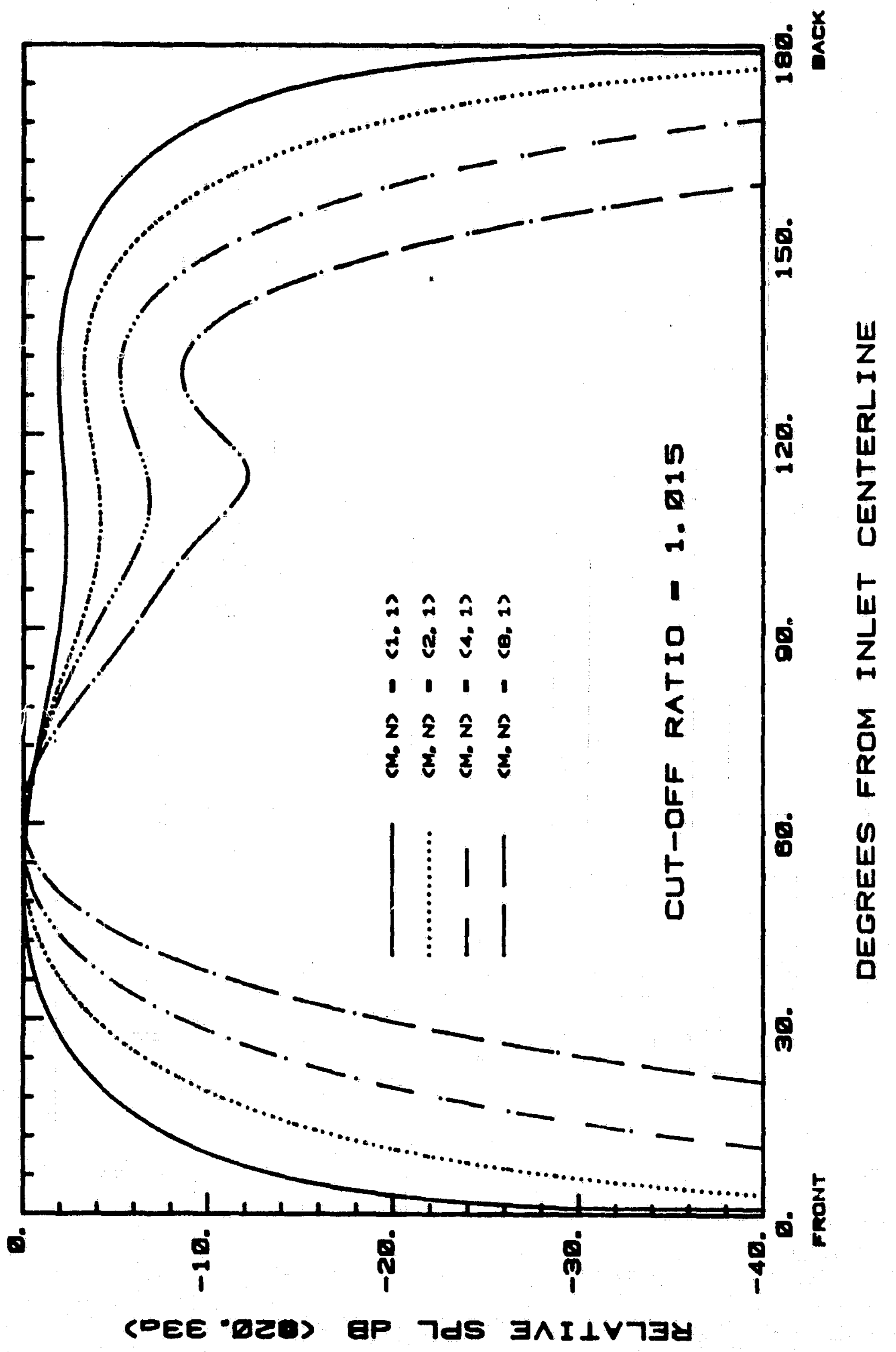

THICK LIPPED ELLIPTICAL INLET

Fig. 54a

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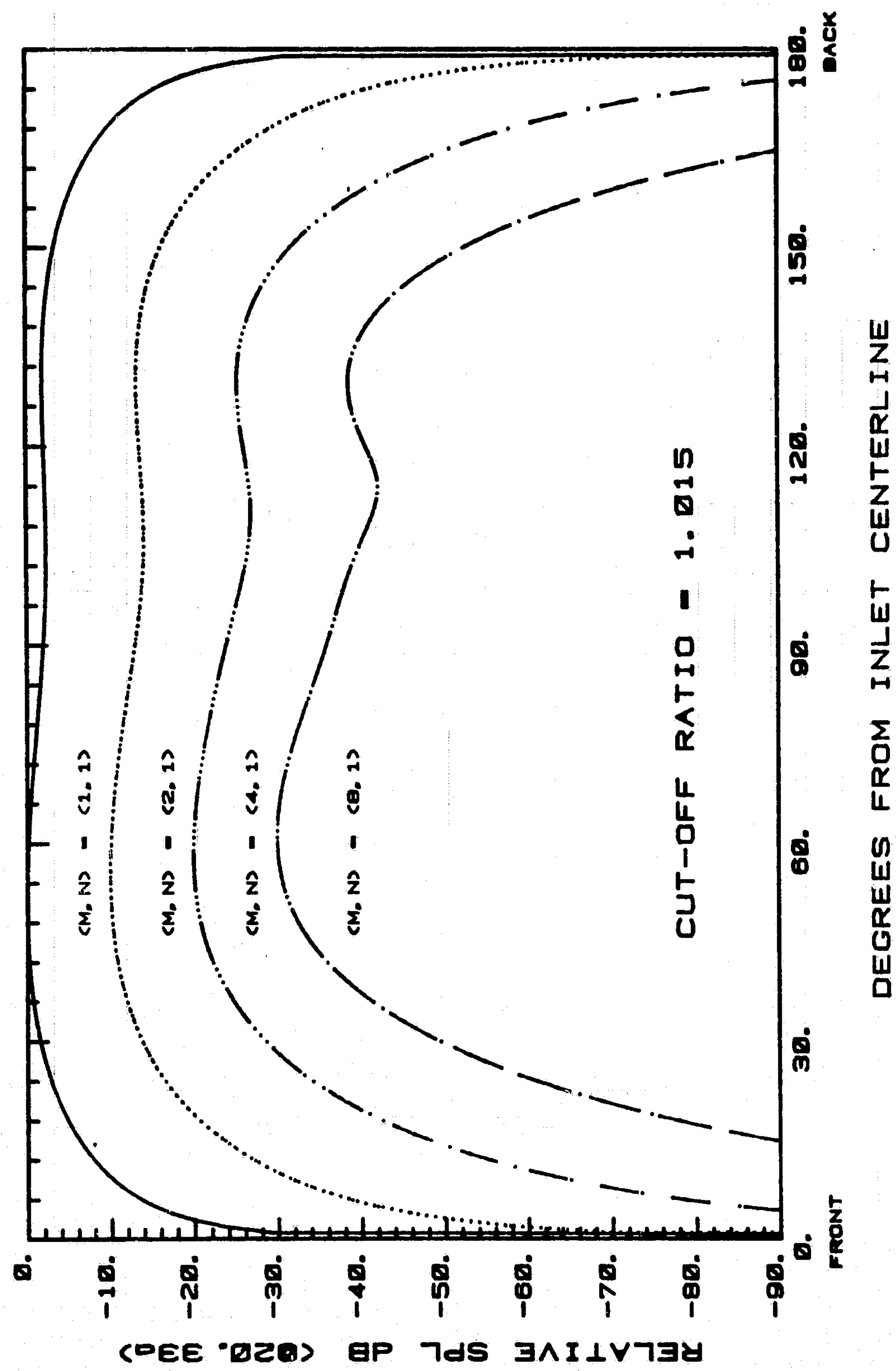
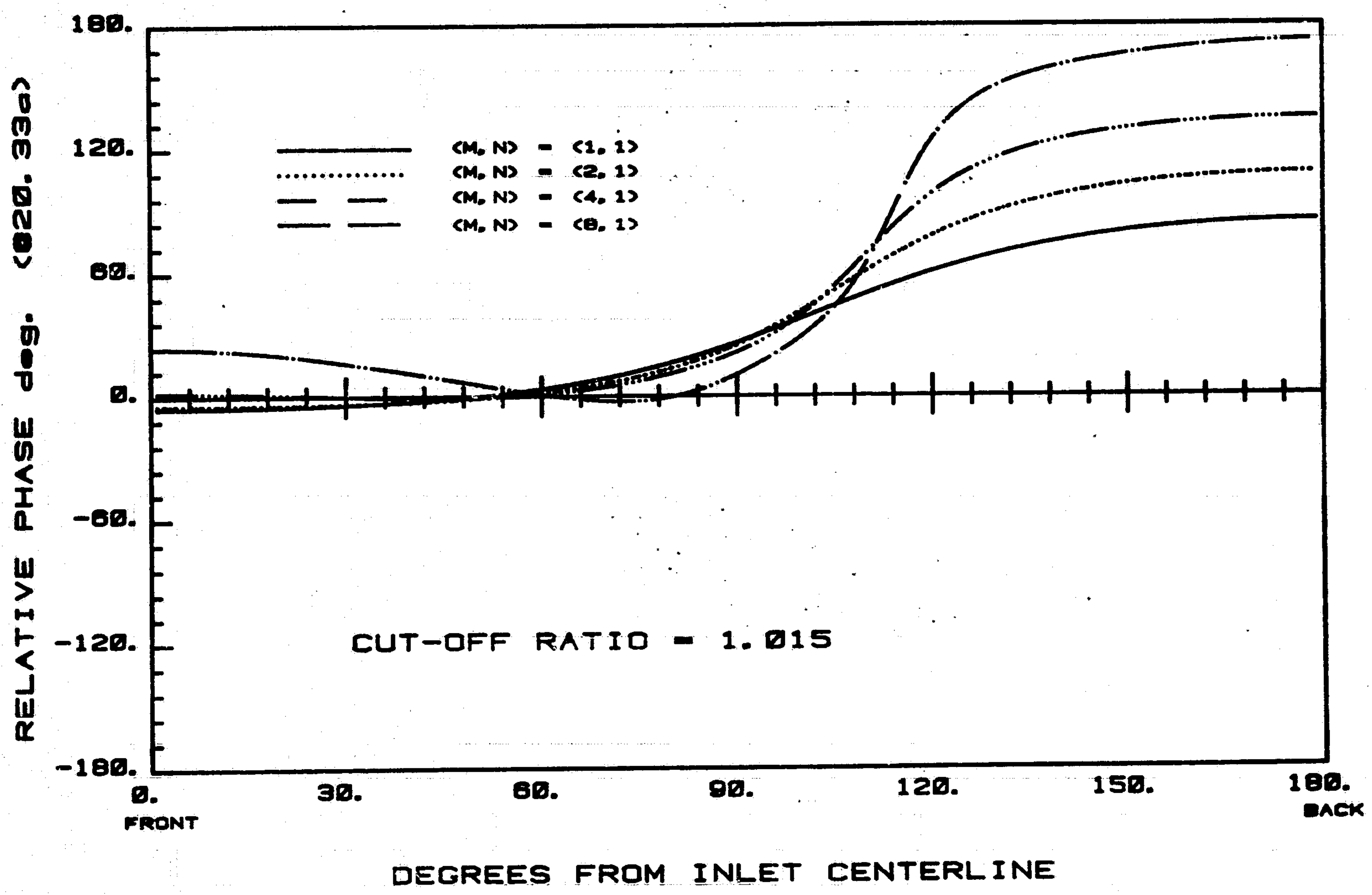


THICK LIPPED ELLIPTICAL INLET

Fig. 54b



THICK LIPPED ELLIPTICAL INLET

Fig. 54c

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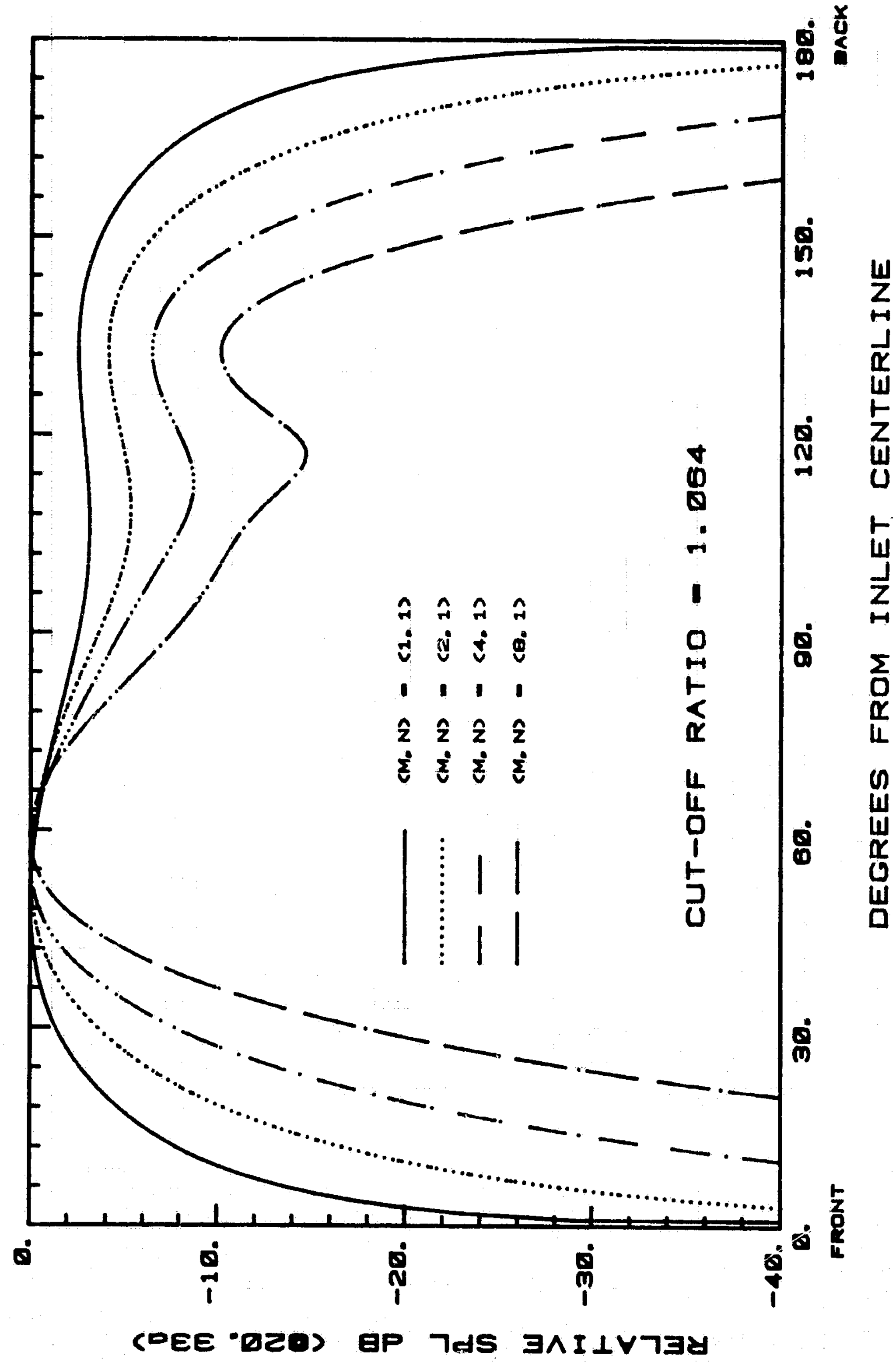
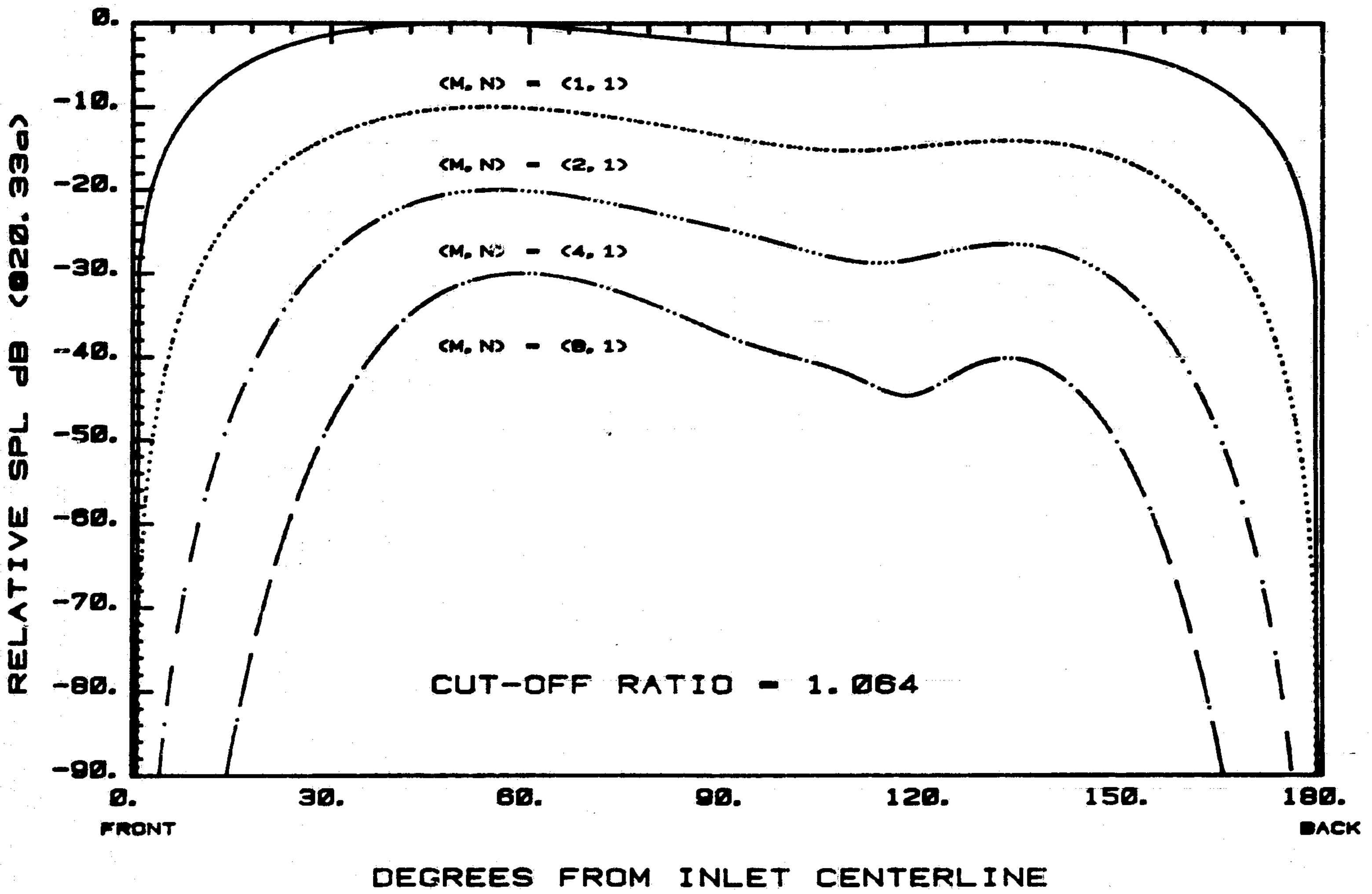


THICK LIPPED ELLIPTICAL INLET

Fig. 55a



THICK LIPPED ELLIPTICAL INLET

Fig. 55b

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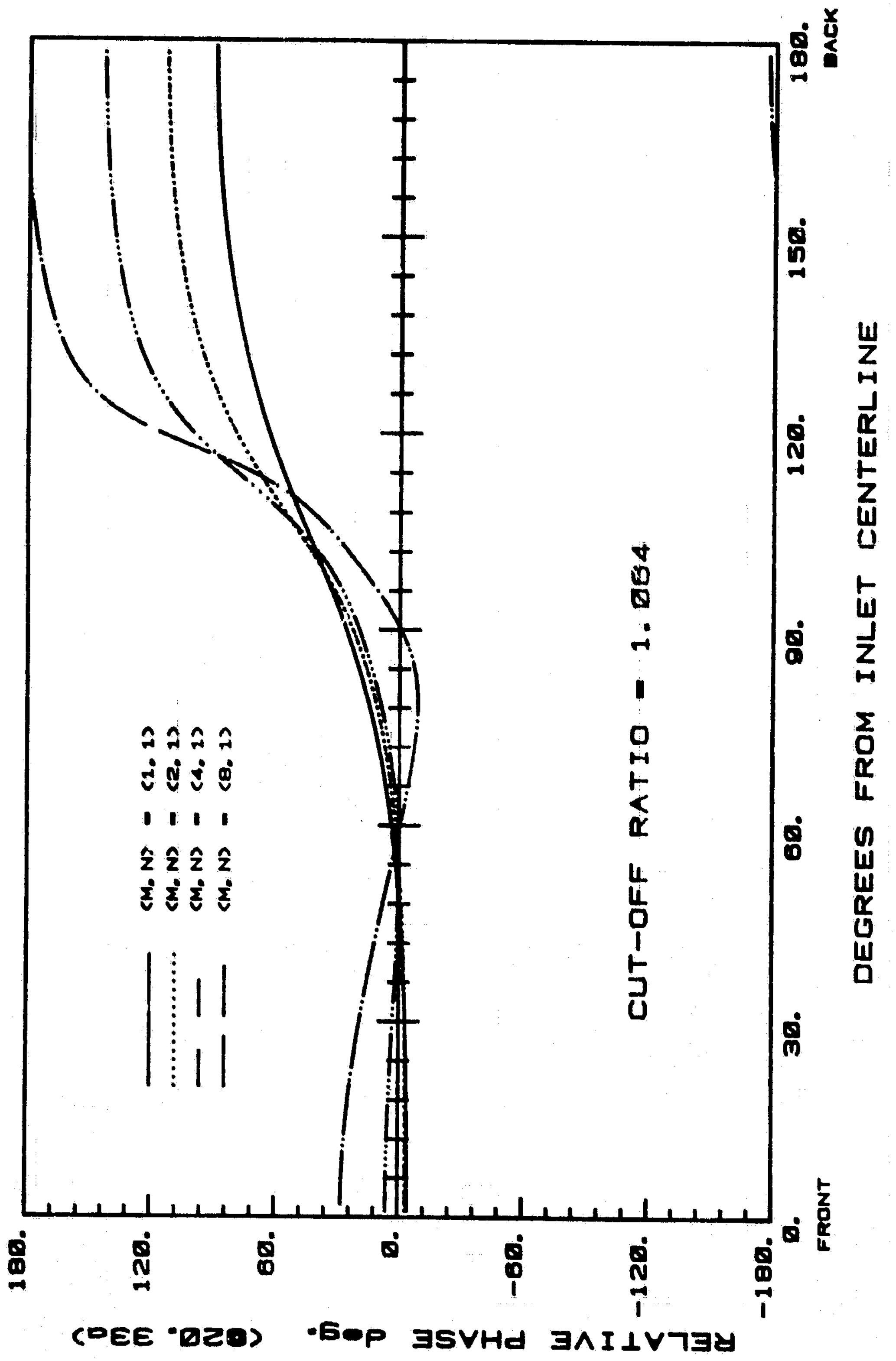
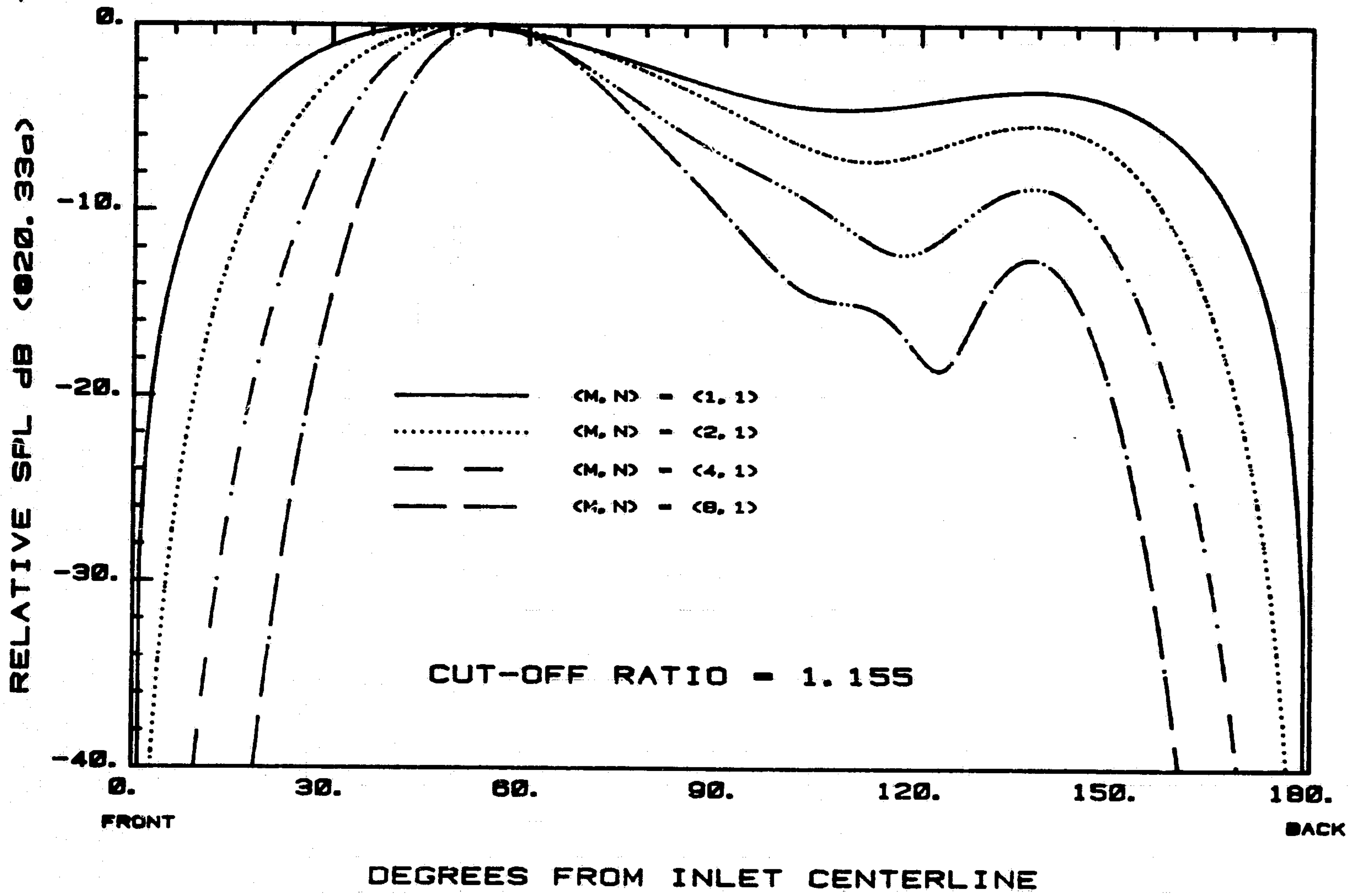


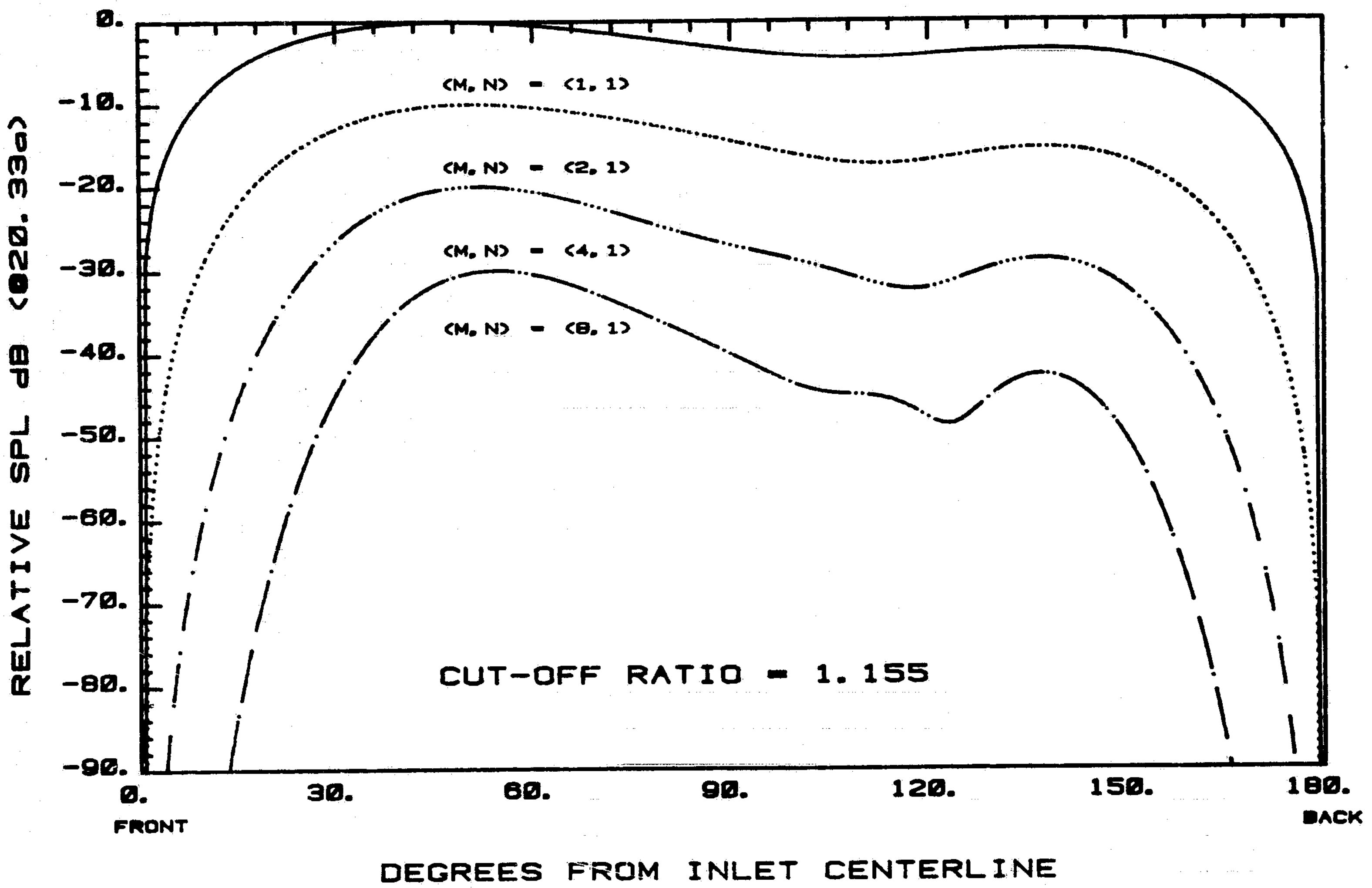
THICK LIPPED ELLIPTICAL INLET

Fig. 55c



THICK LIPPED ELLIPTICAL INLET

Fig. 56a



THICK LIPPED ELLIPTICAL INLET

Fig. 56b

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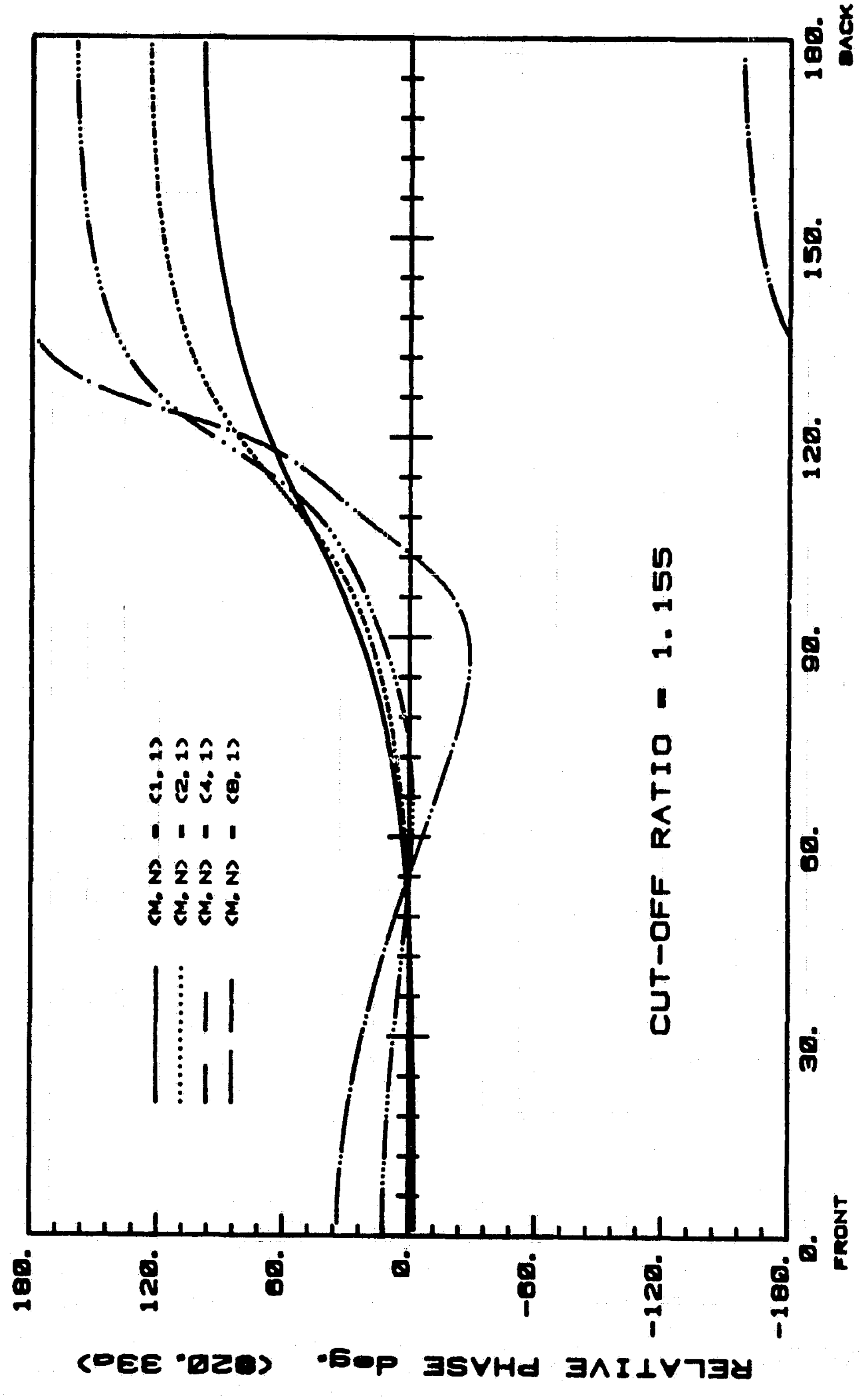
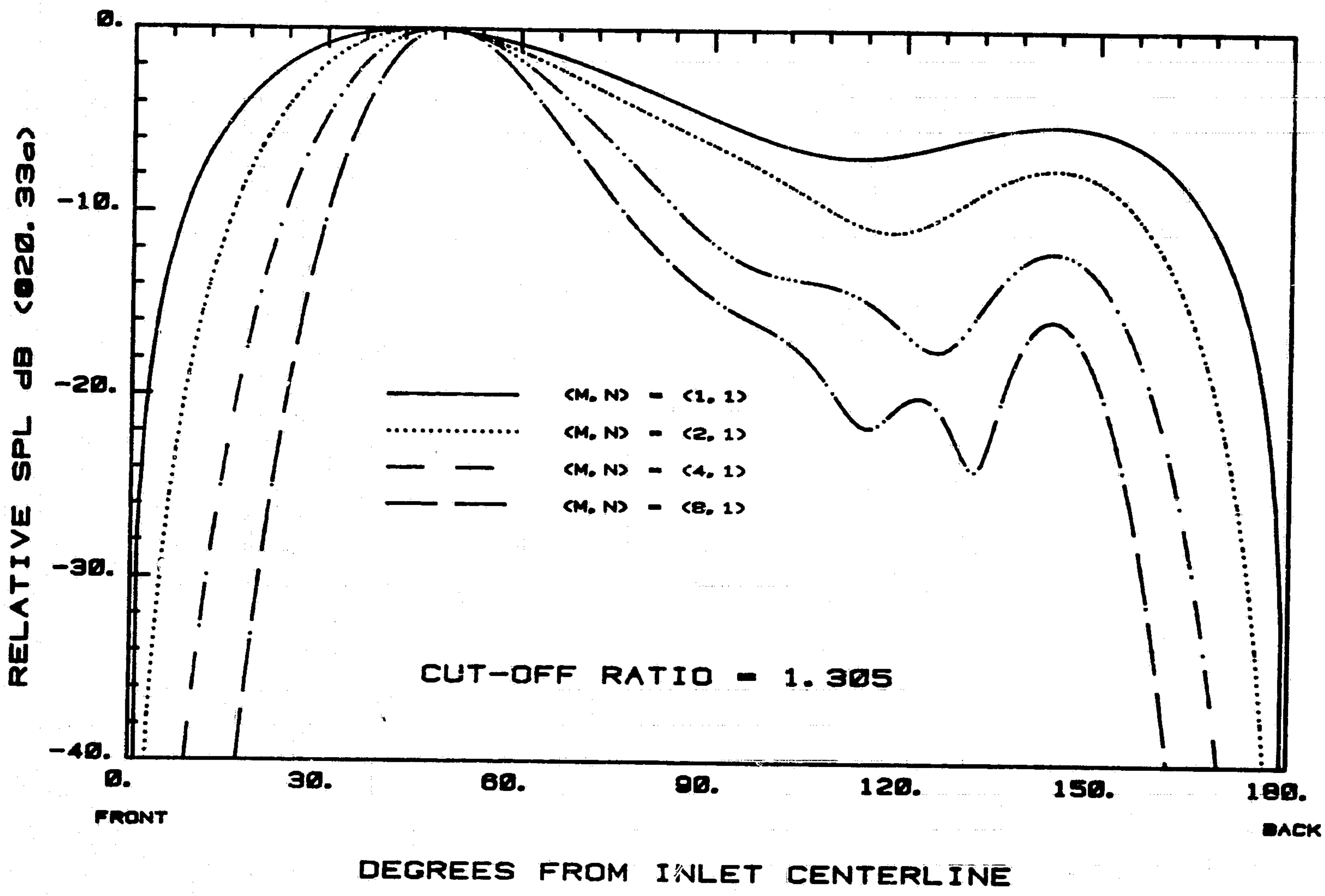


THICK LIPPED ELLIPTICAL INLET

Fig. 56c



THICK LIPPED ELLIPTICAL INLET

Fig. 57a

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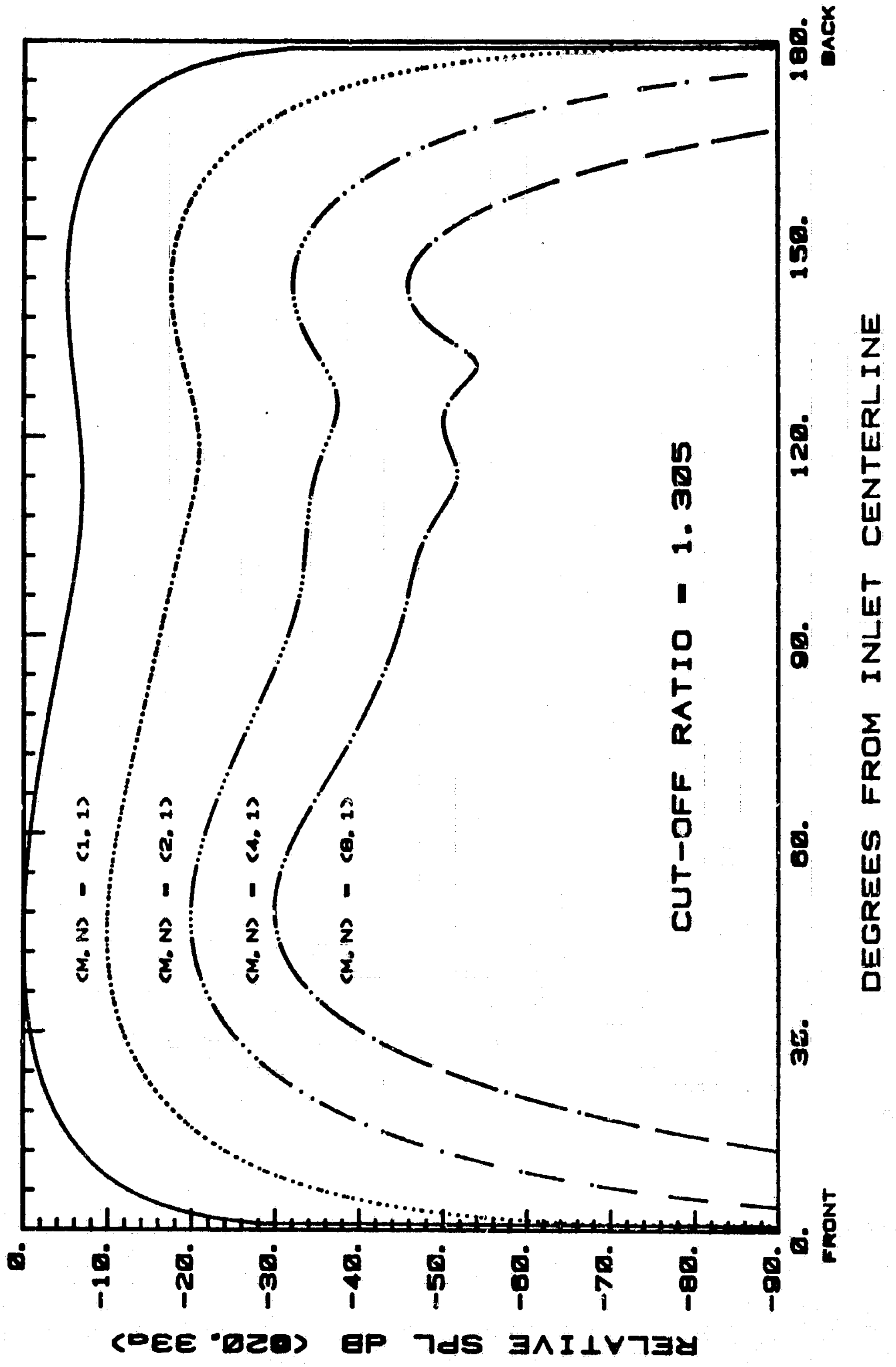
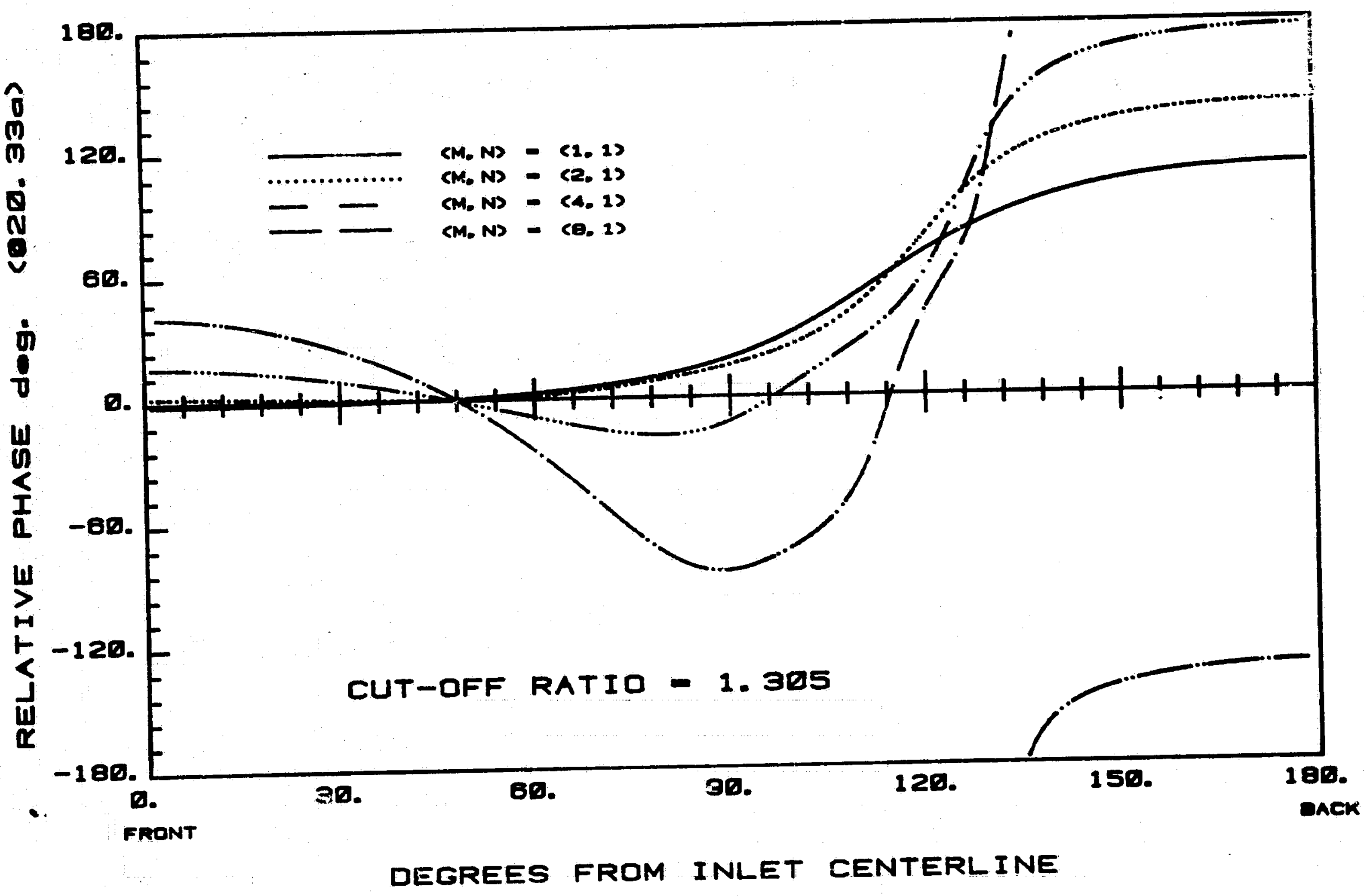


THICK LIPPED ELLIPTICAL INLET

Fig. 57b



THICK LIPPED ELLIPTICAL INLET

Fig. 57c

C-4

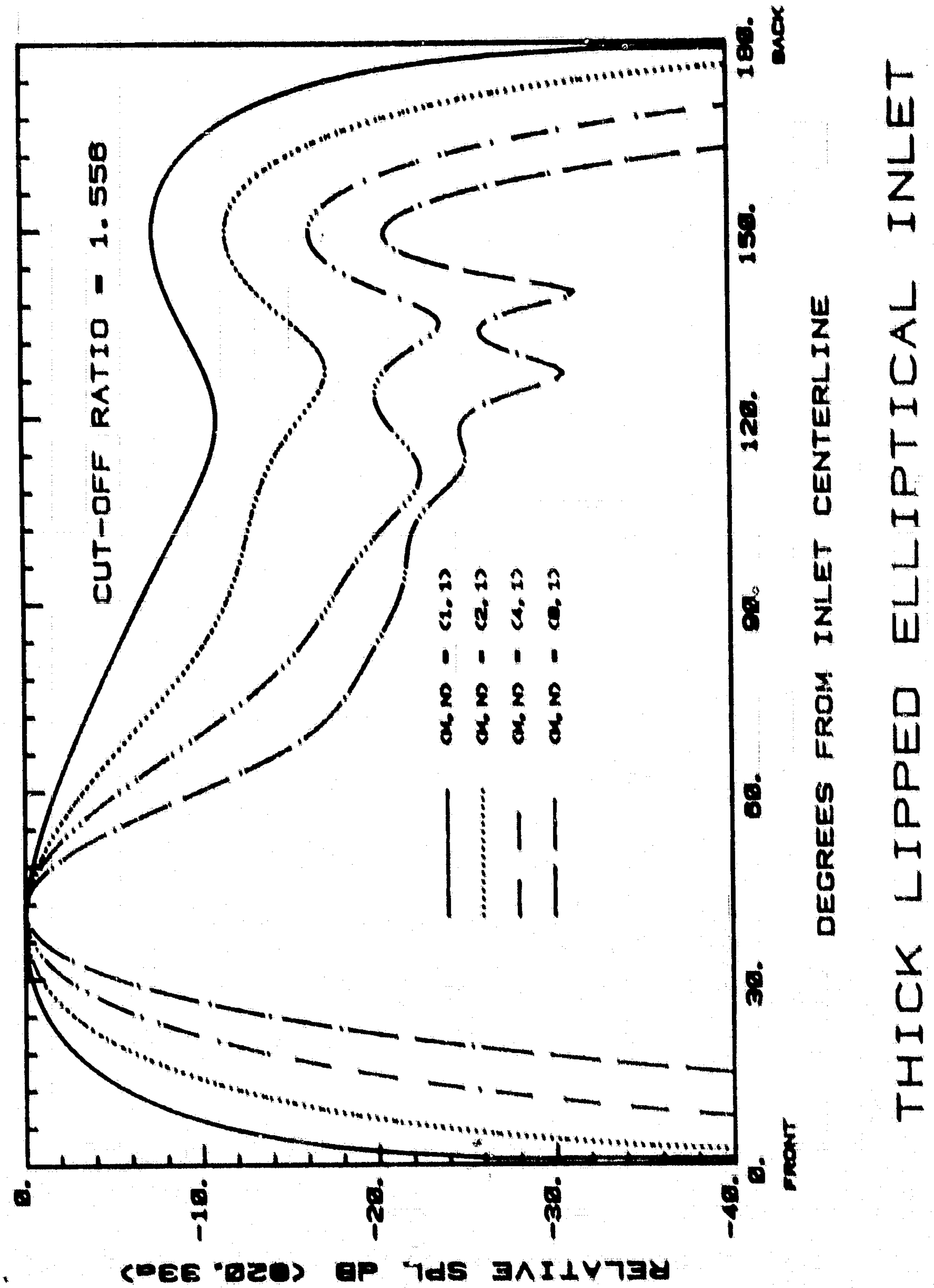

CUT-OFF RATIO = 1.558
(M,N) = (1,1)
(M,N) = (2,1)
(M,N) = (4,1)
(M,N) = (8,1)
0.
30.
60.
90.
120.
150.
180.
FRONT
BACK
DEGREES FROM INLET CENTERLINE
0.
-10.
-20.
-30.
-40.
RELATIVE SPL, dB (020, 33a)
THICK LIPPED ELLIPTICAL INLET

Fig. 58a

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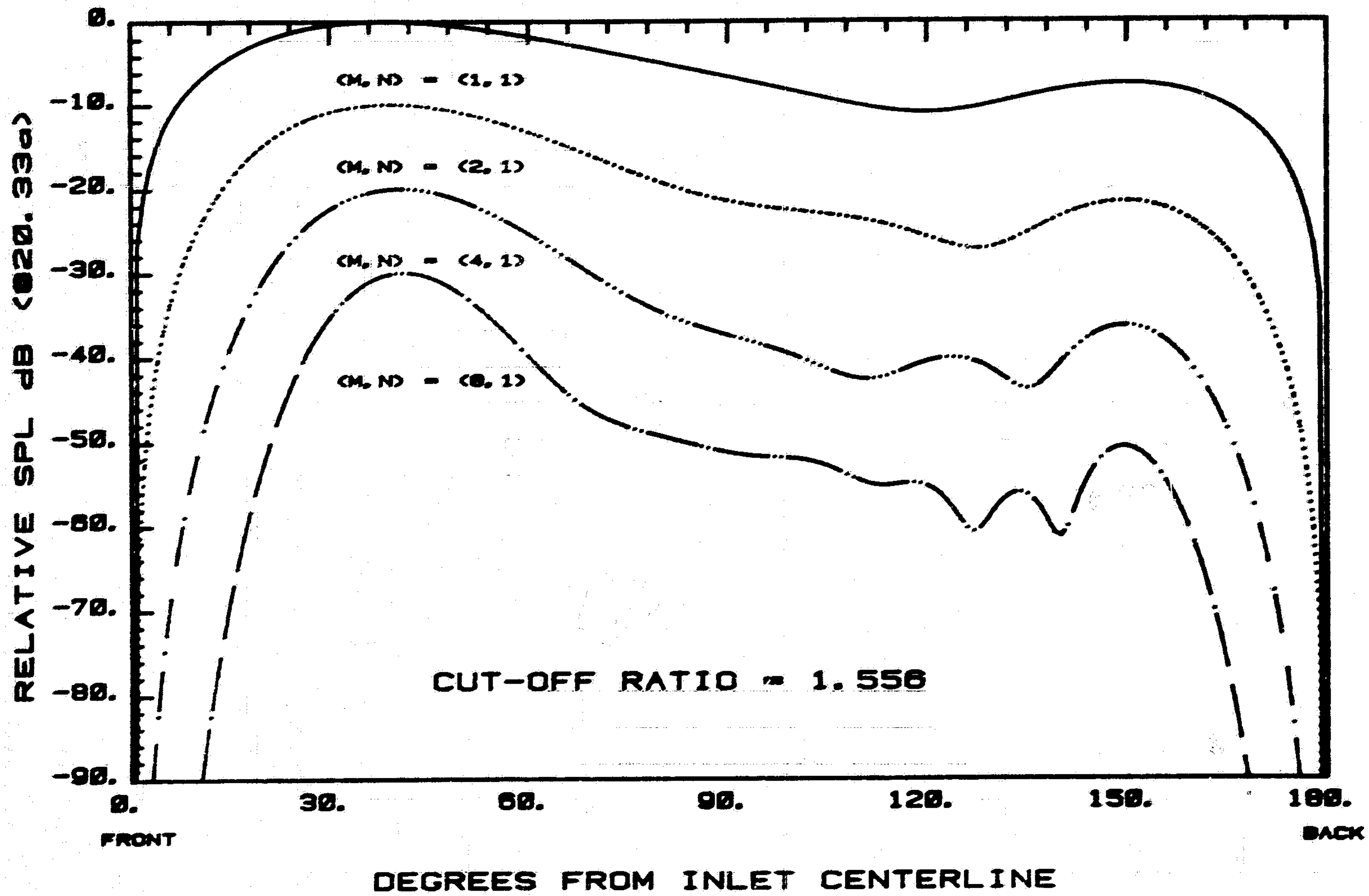
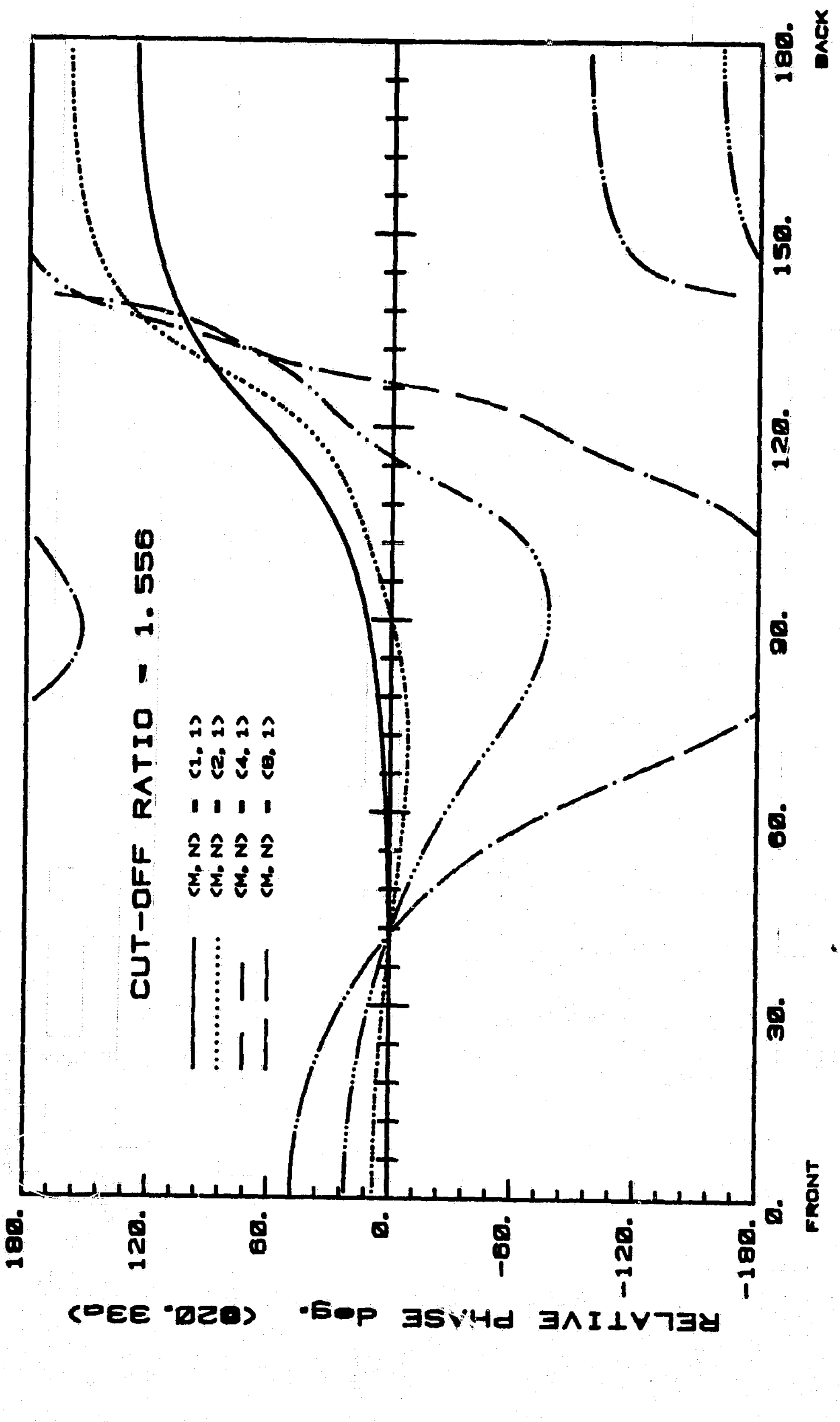


THICK LIPPED ELLIPTICAL INLET

Fig. 58b



THICK LIPPED ELLIPTICAL INLET

Fig. 58c

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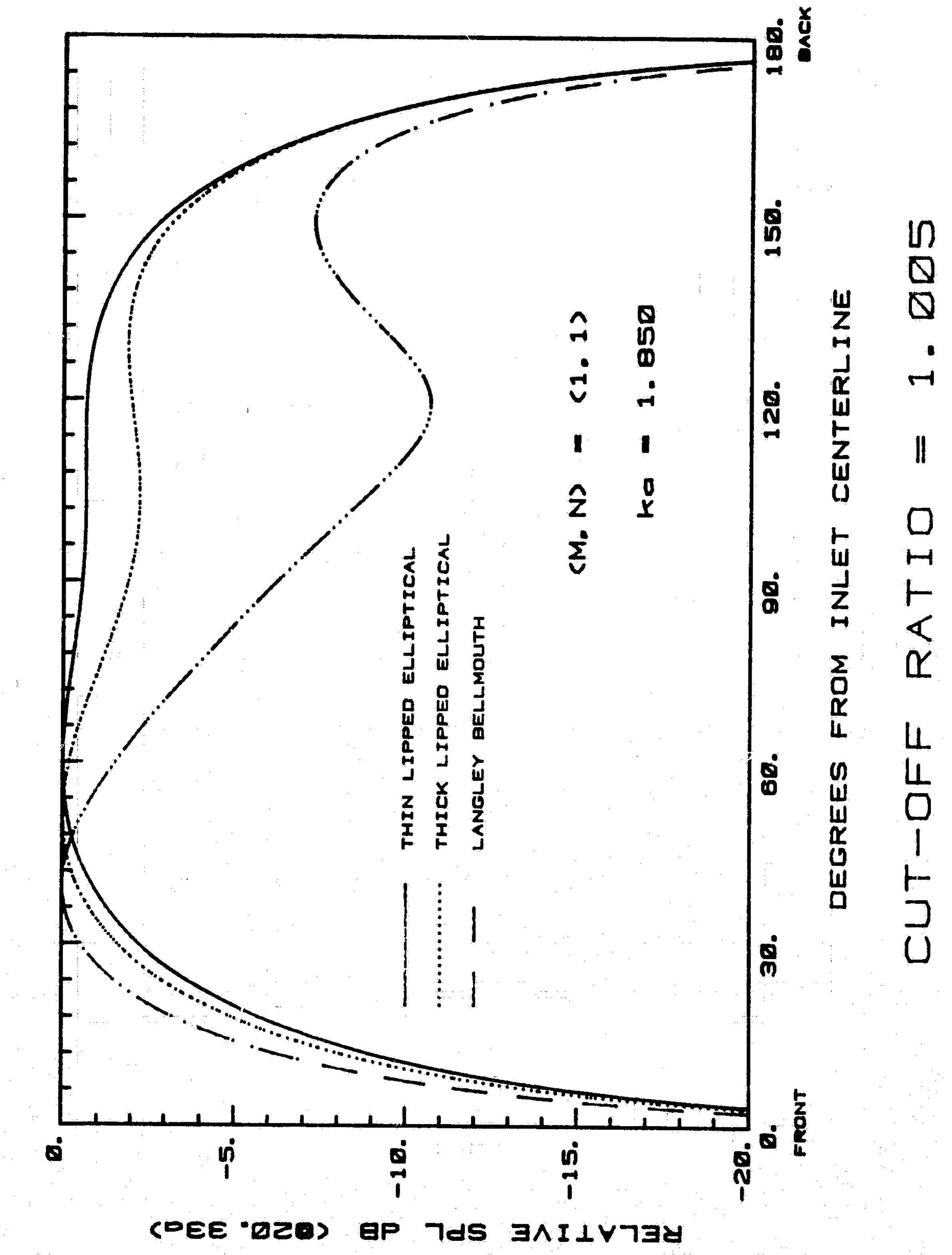
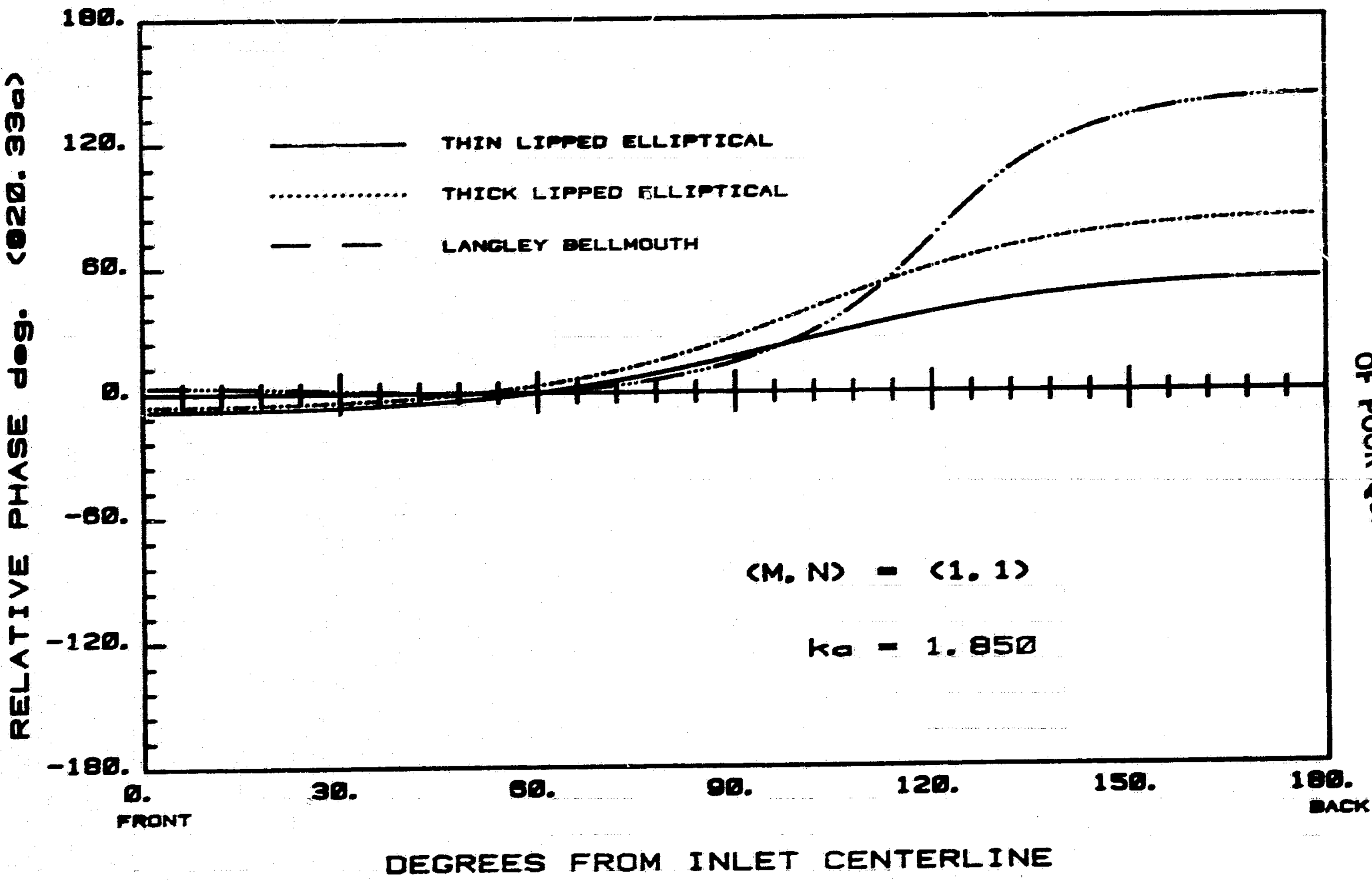


Fig. 59a



CUT-OFF RATIO = 1.005

Fig. 59b

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OF POOR QUALITY

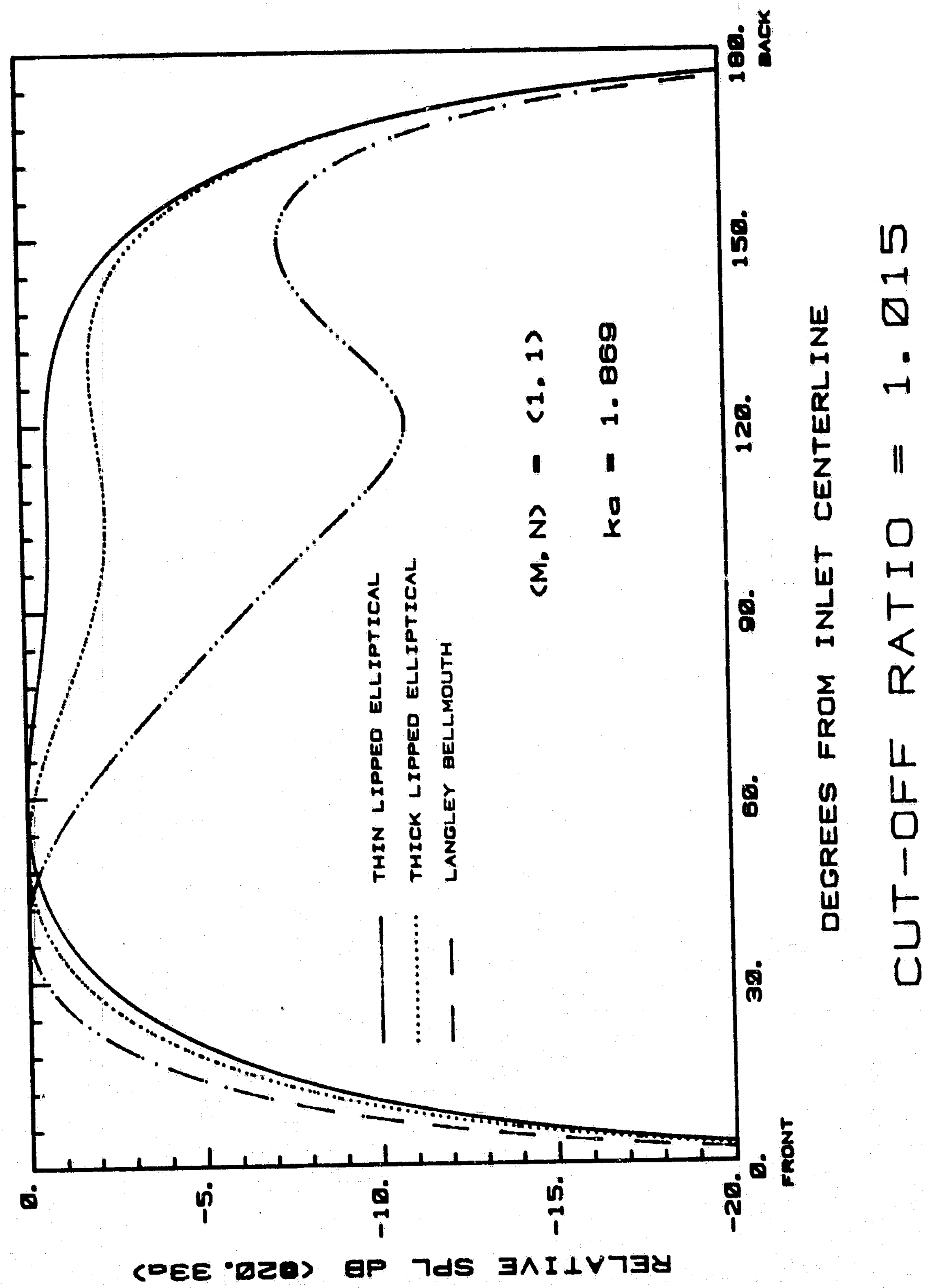

Fig. 59c

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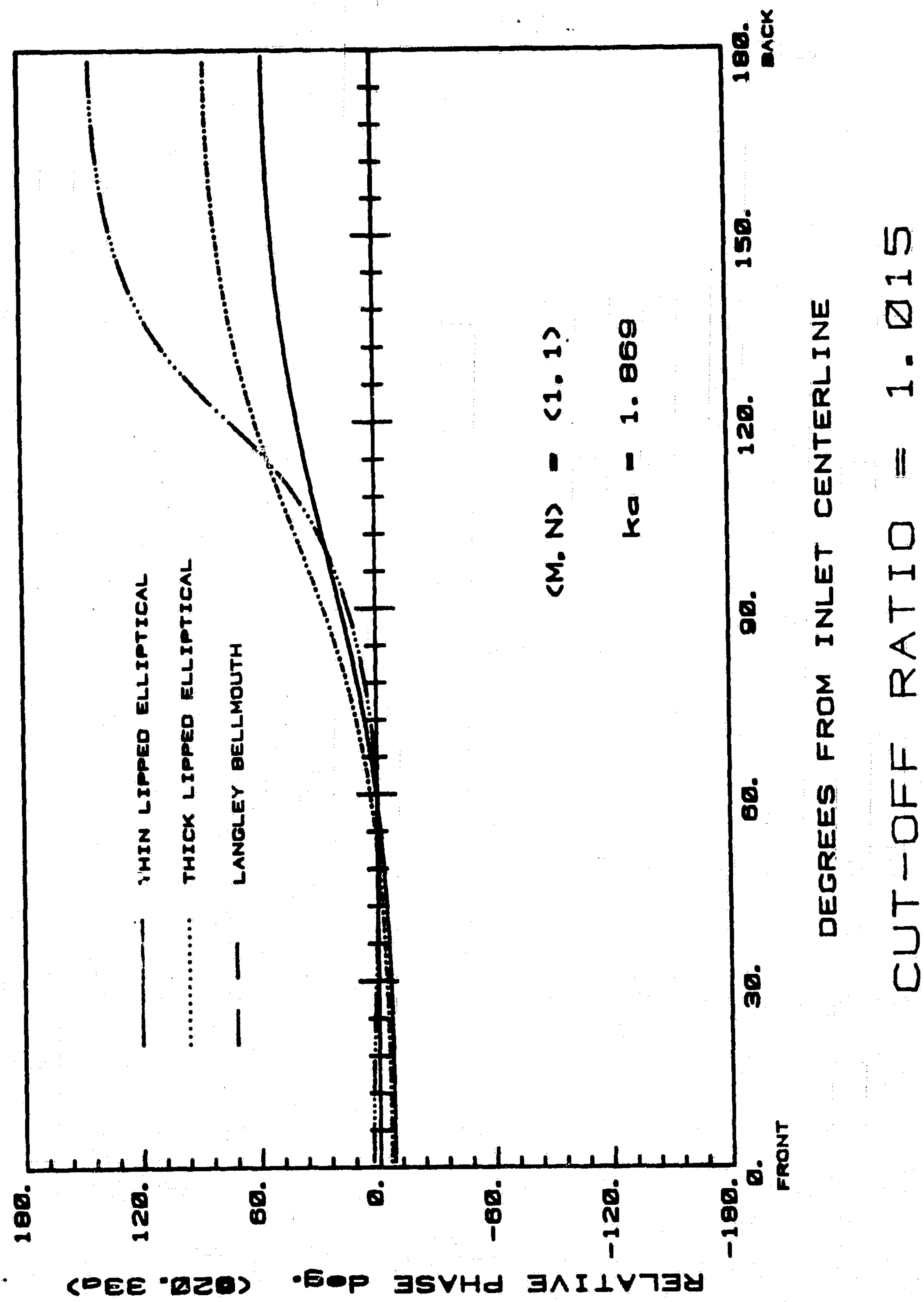
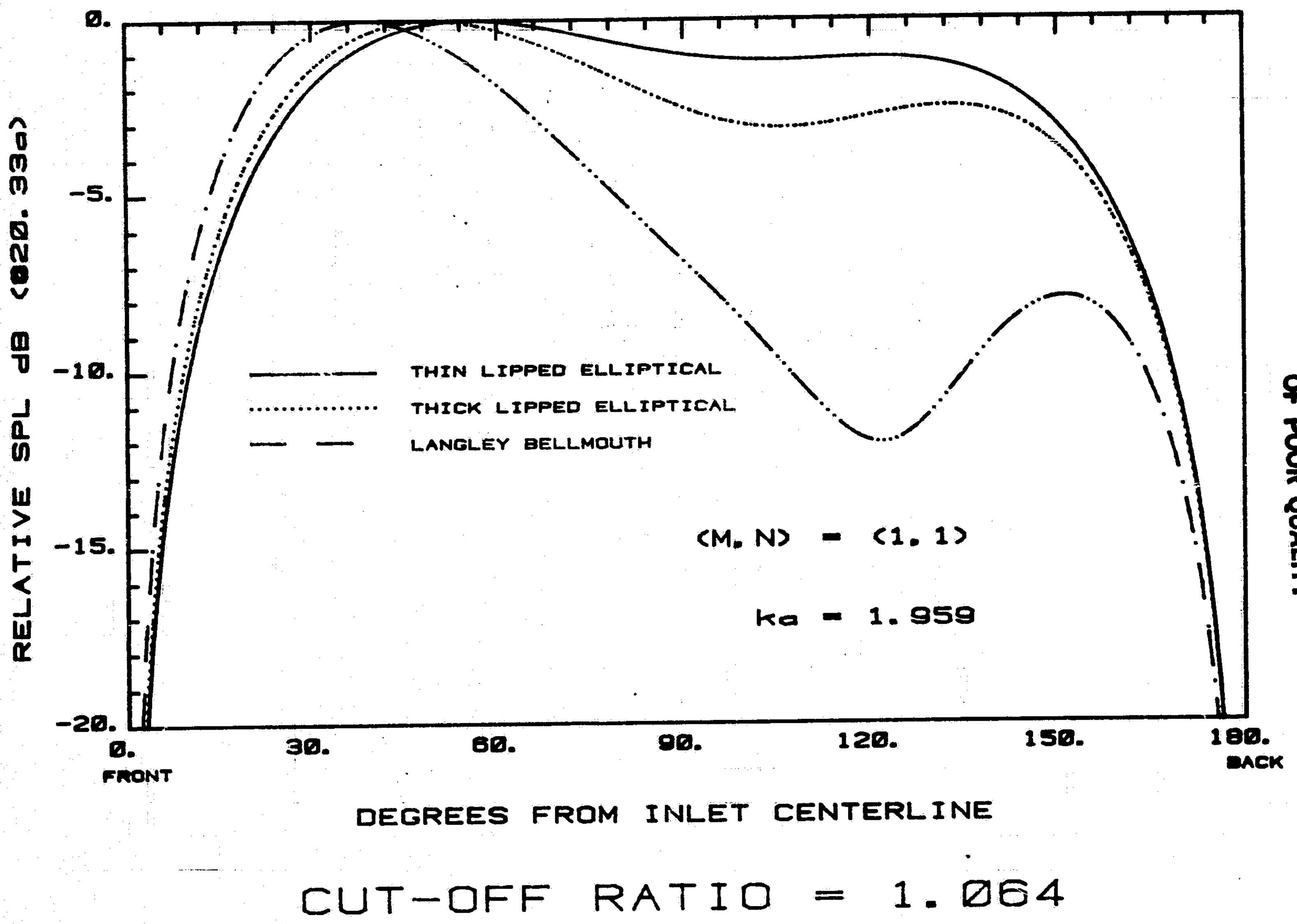


Fig. 59d



RELATIVE SPL dB (020. 33a)
0.
-5.
-10.
-15.
-20.
0.
FRONT
30.
60.
90.
120.
150.
180.
BACK
DEGREES FROM INLET CENTERLINE
THIN LIPPED ELLIPTICAL
THICK LIPPED ELLIPTICAL
LANGLEY BELLMOUTH
(M, N) = (1, 1)
ka = 1.959
CUT-OFF RATIO = 1.064

Fig.59e

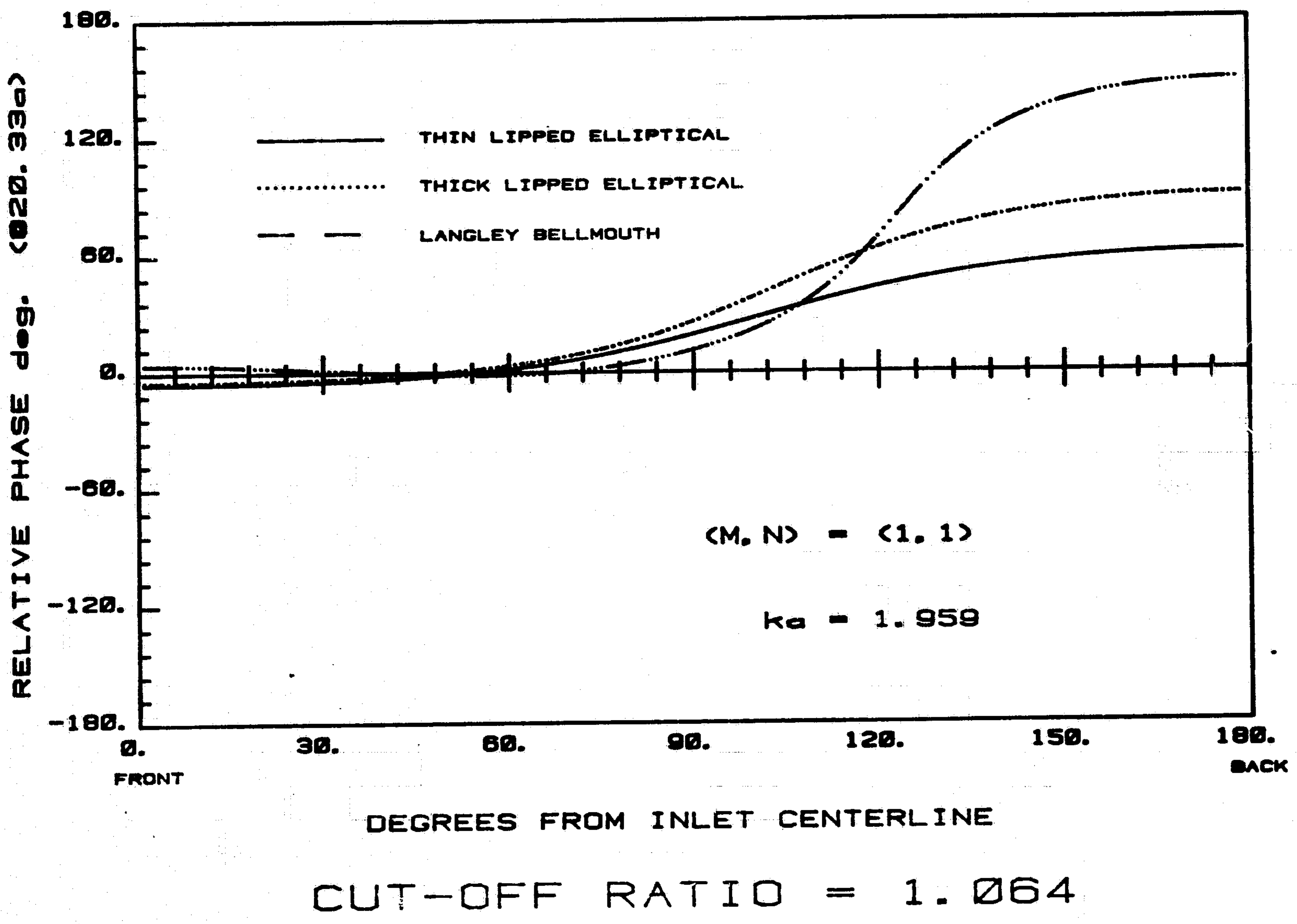
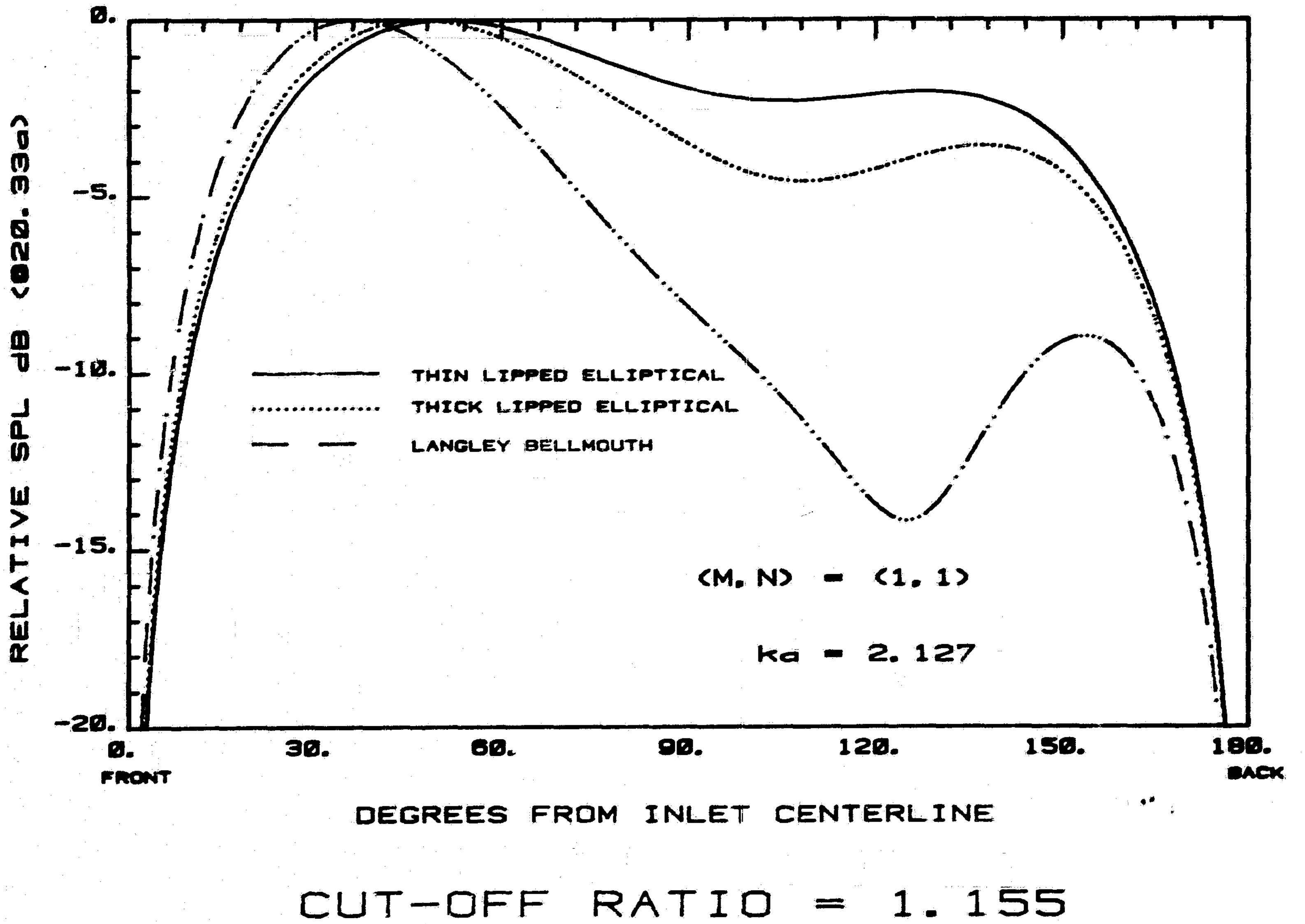

RELATIVE PHASE deg. (020. 33a)
180.
120.
60.
0.
-60.
-120.
-180.
THIN LIPPED ELLIPTICAL
THICK LIPPED ELLIPTICAL
LANGLEY BELLMOUTH
(M, N) = (1, 1)
ka = 1.959
0.
FRONT
30.
60.
90.
120.
150.
180.
BACK
DEGREES FROM INLET CENTERLINE
CUT-OFF RATIO = 1.064

Fig. 59f



RELATIVE SPL dB (020.33a)
0.
-5.
-10.
-15.
-20.
0.
FRONT
30.
60.
90.
120.
150.
180.
BACK
DEGREES FROM INLET CENTERLINE
THIN LIPPED ELLIPTICAL
THICK LIPPED ELLIPTICAL
LANGLEY BELLMOUTH
(M, N) = (1, 1)
ka = 2.127
CUT-OFF RATIO = 1.155

Fig. 59g

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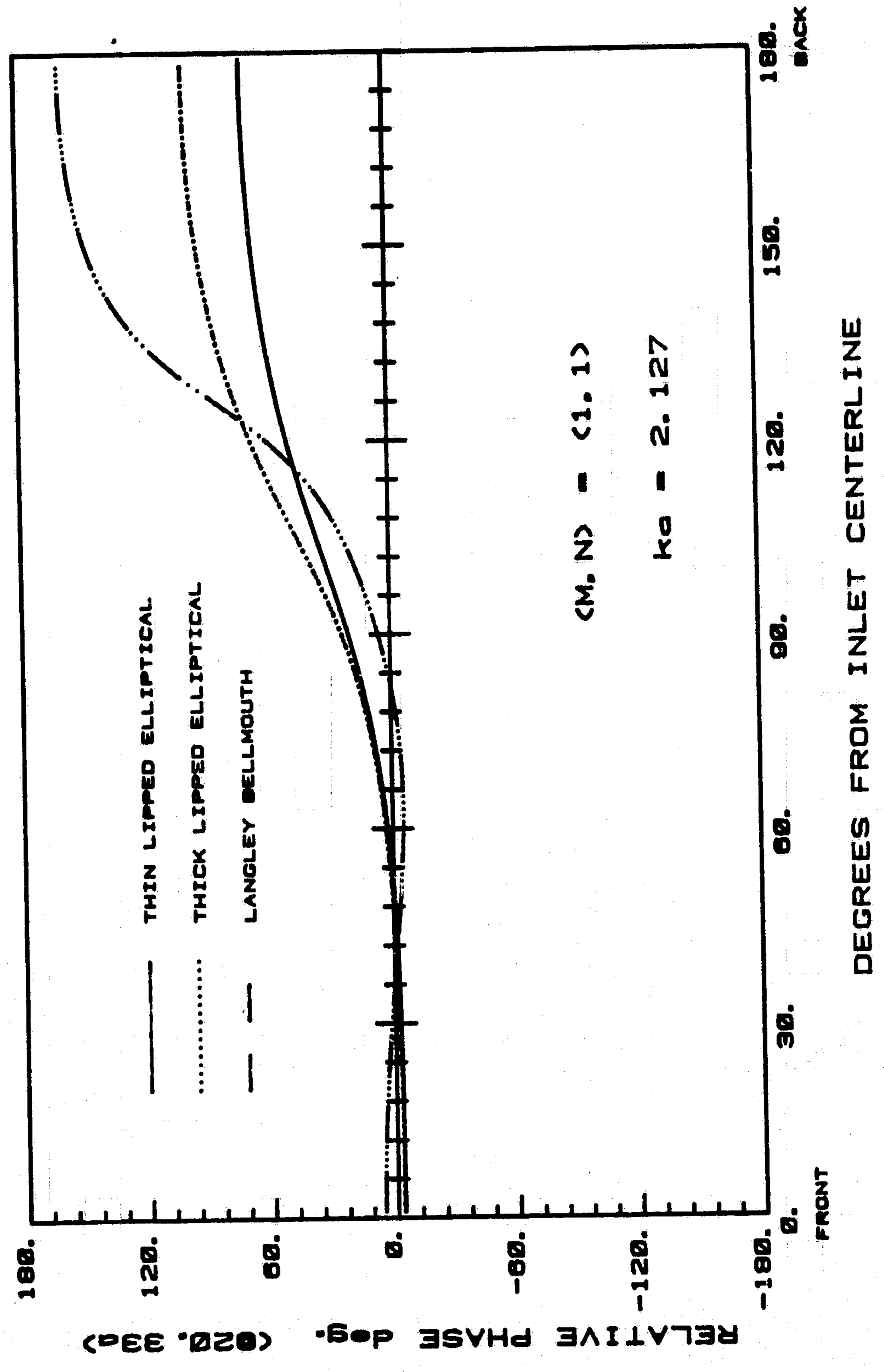

CUT-OFF RATIO = 1.155

Fig.59h

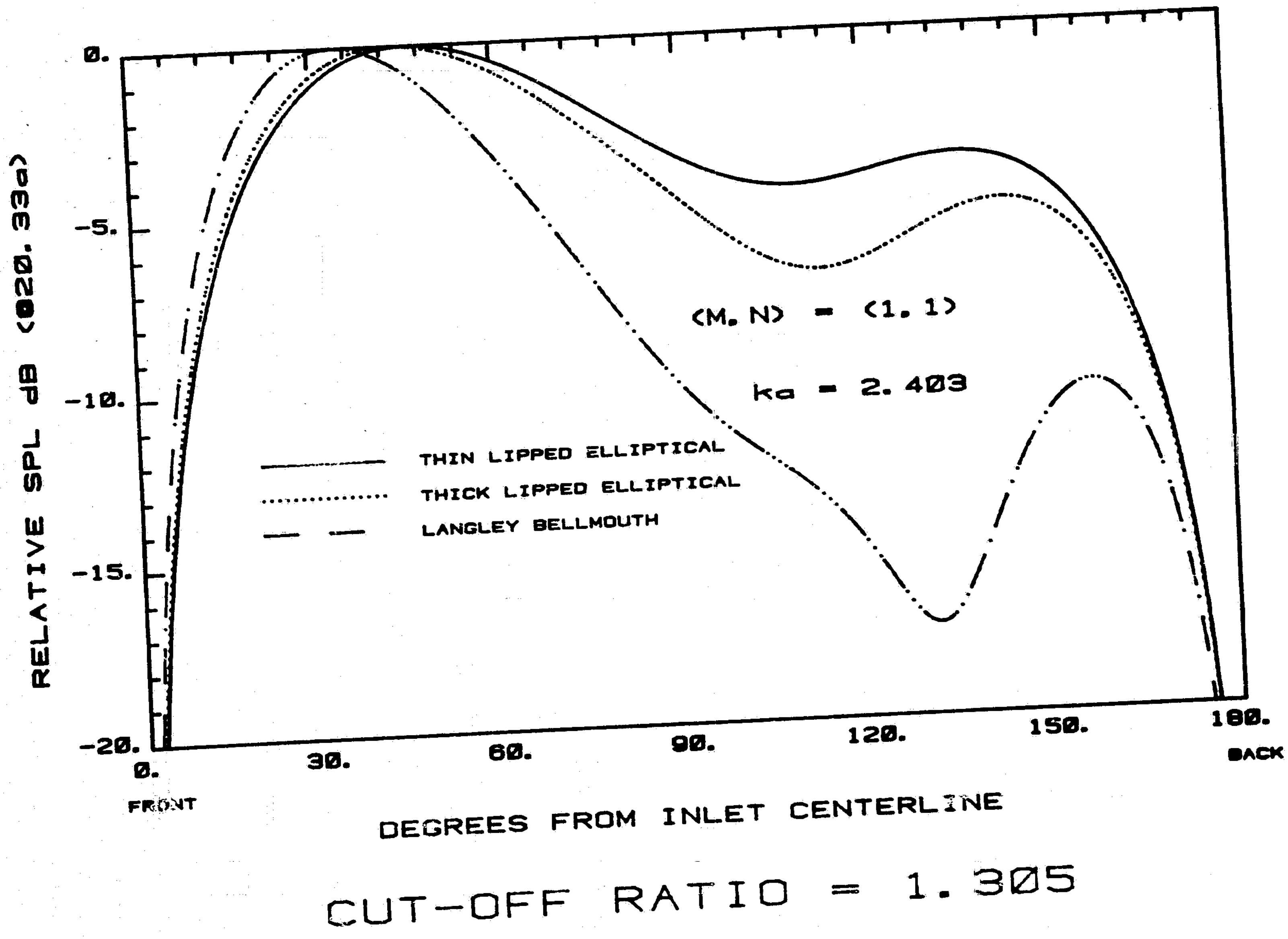
RELATIVE SPL dB (020. 33a)
0.
-5.
-10.
-15.
-20.
0.
30.
60.
90.
120.
150.
180.
FRONT
BACK
DEGREES FROM INLET CENTERLINE
(M. N) = (1. 1)
ka = 2. 403
THIN LIPPED ELLIPTICAL
THICK LIPPED ELLIPTICAL
LANGLEY BELLMOUTH
CUT-OFF RATIO = 1. 305

Fig. 59i

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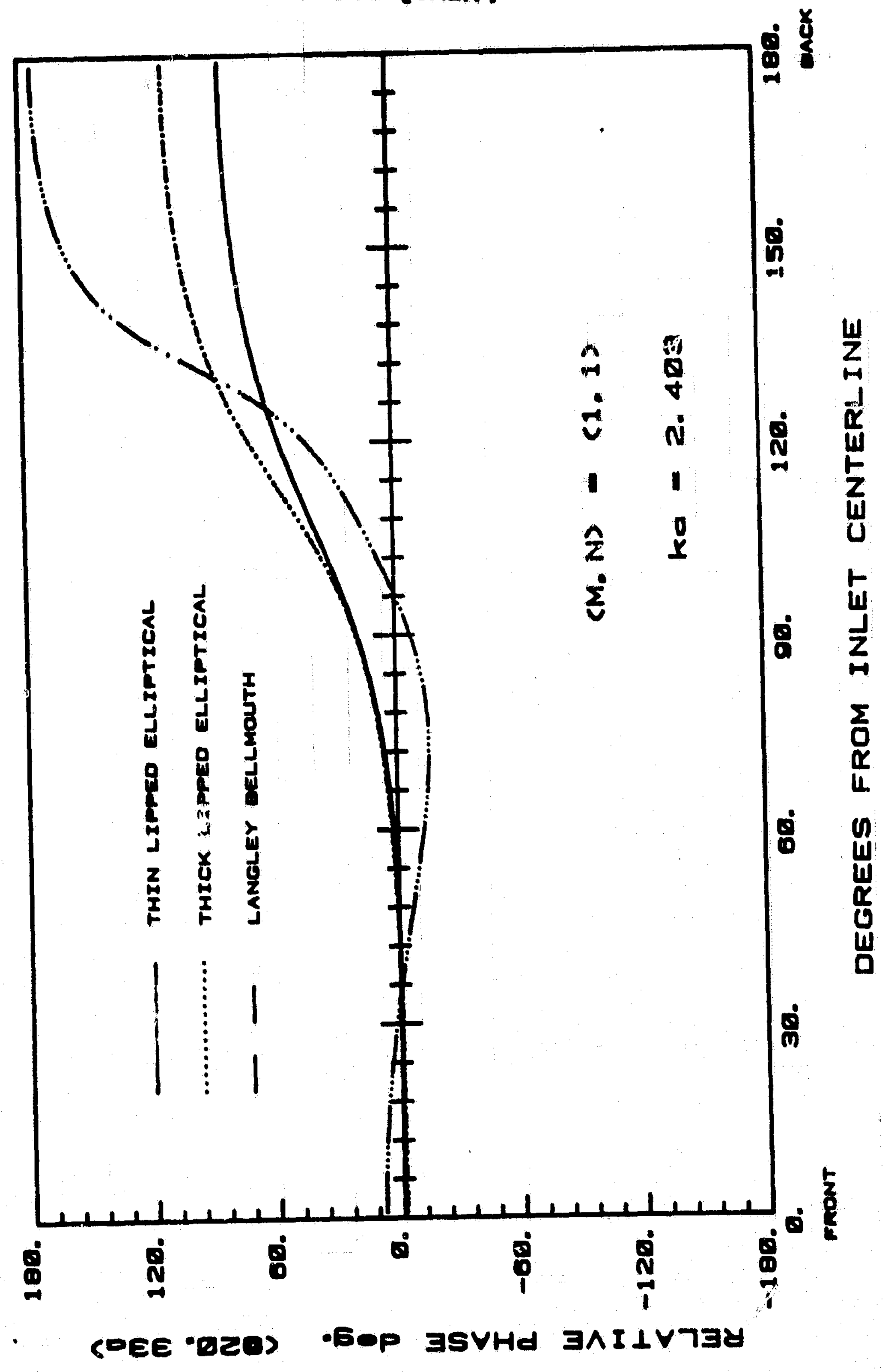

CUT-OFF RATIO = 1.305

Fig. 59j

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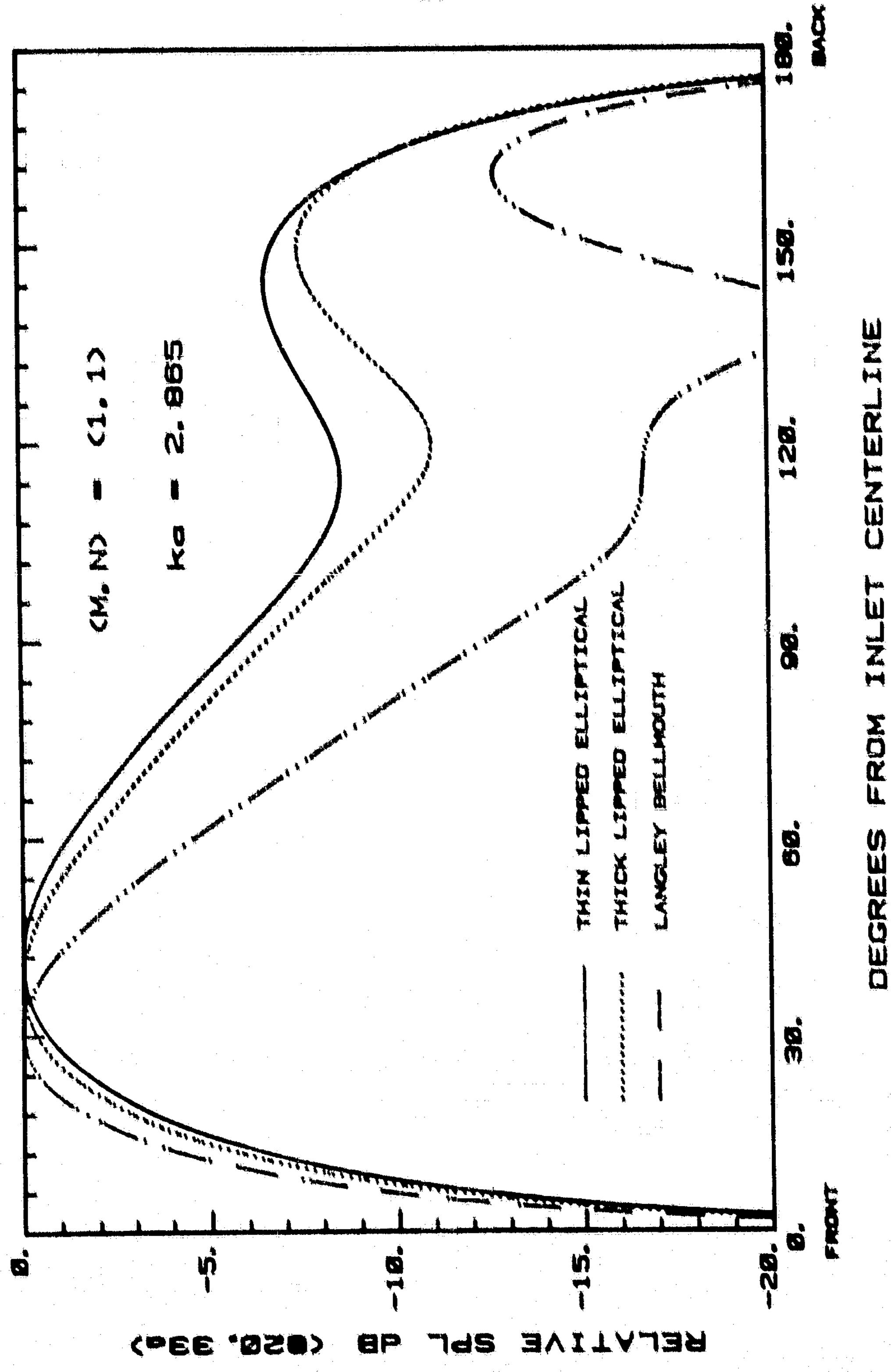

CUT-OFF RATIO = 1.556

Fig. 39k

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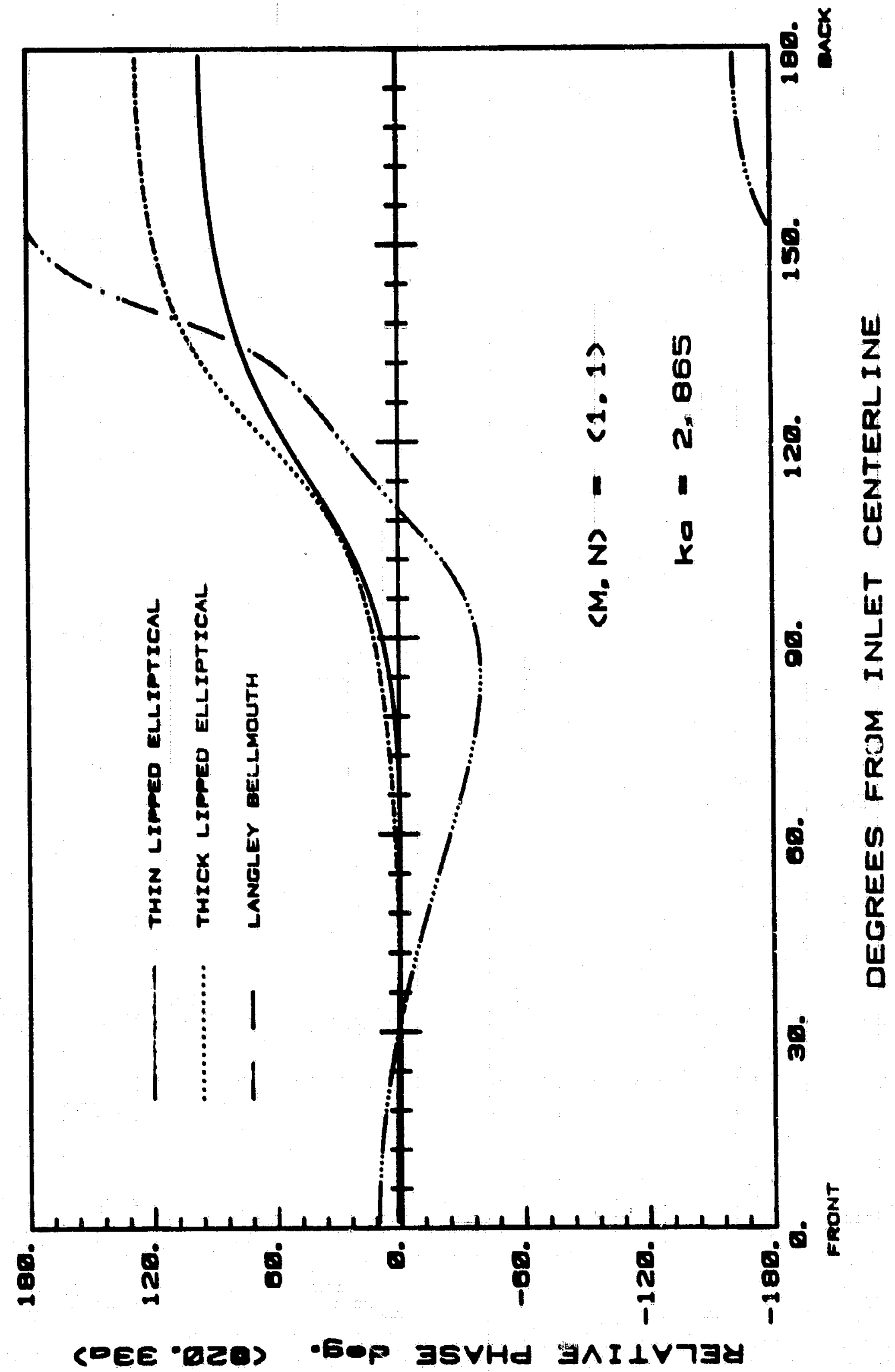

CUT-OFF RATIO = 1.556

Fig. 591

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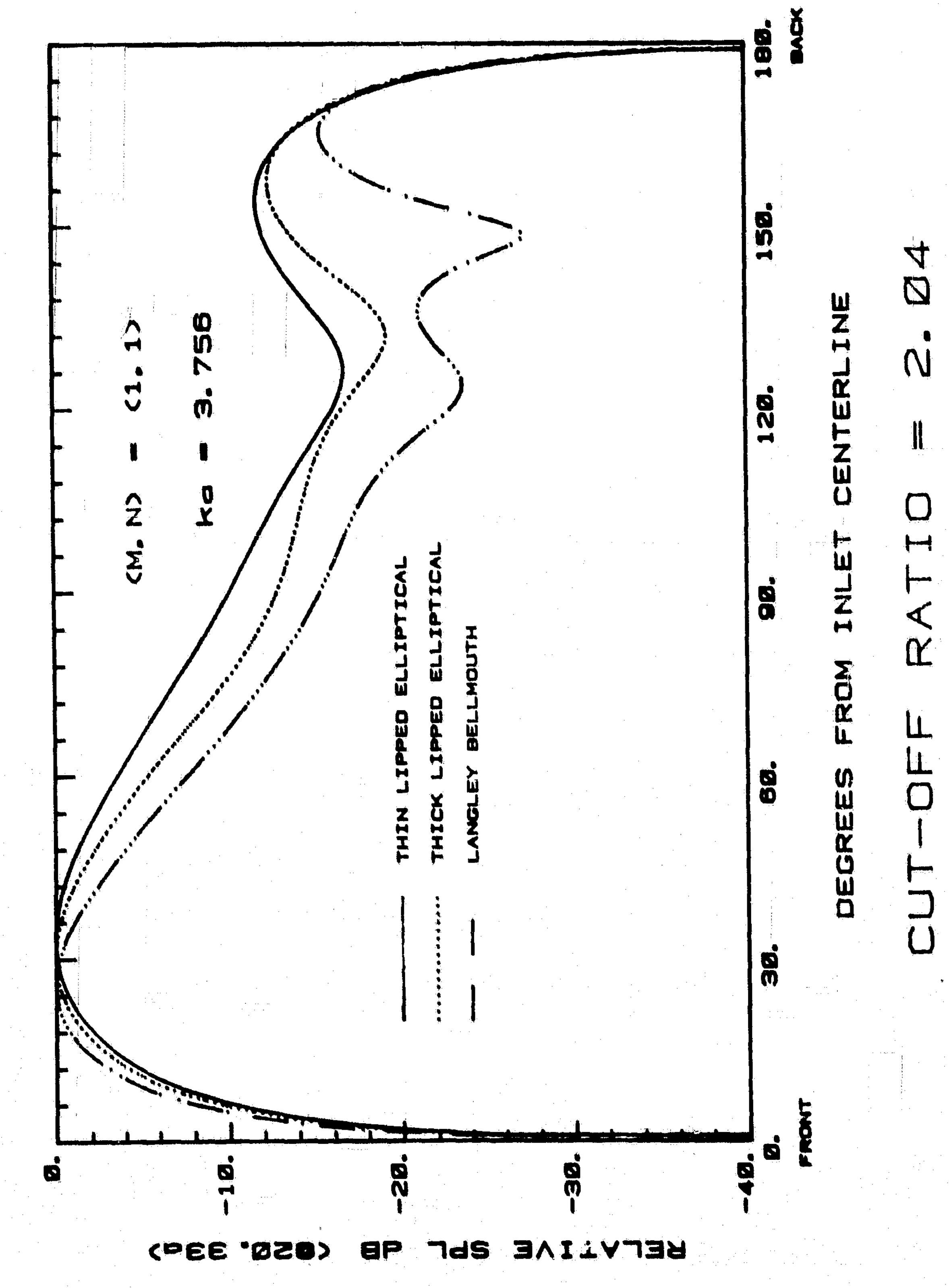

Fig. 59m

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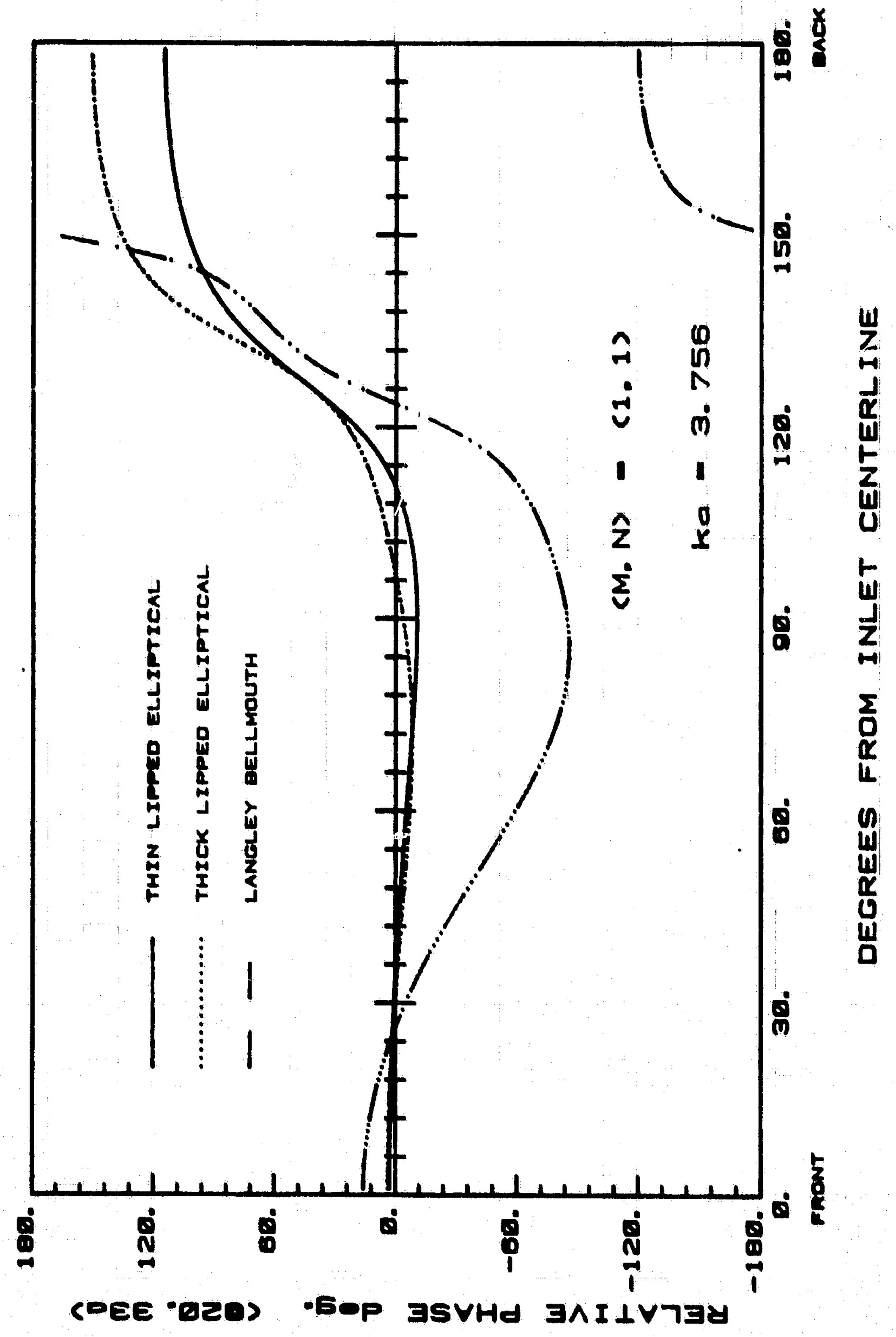
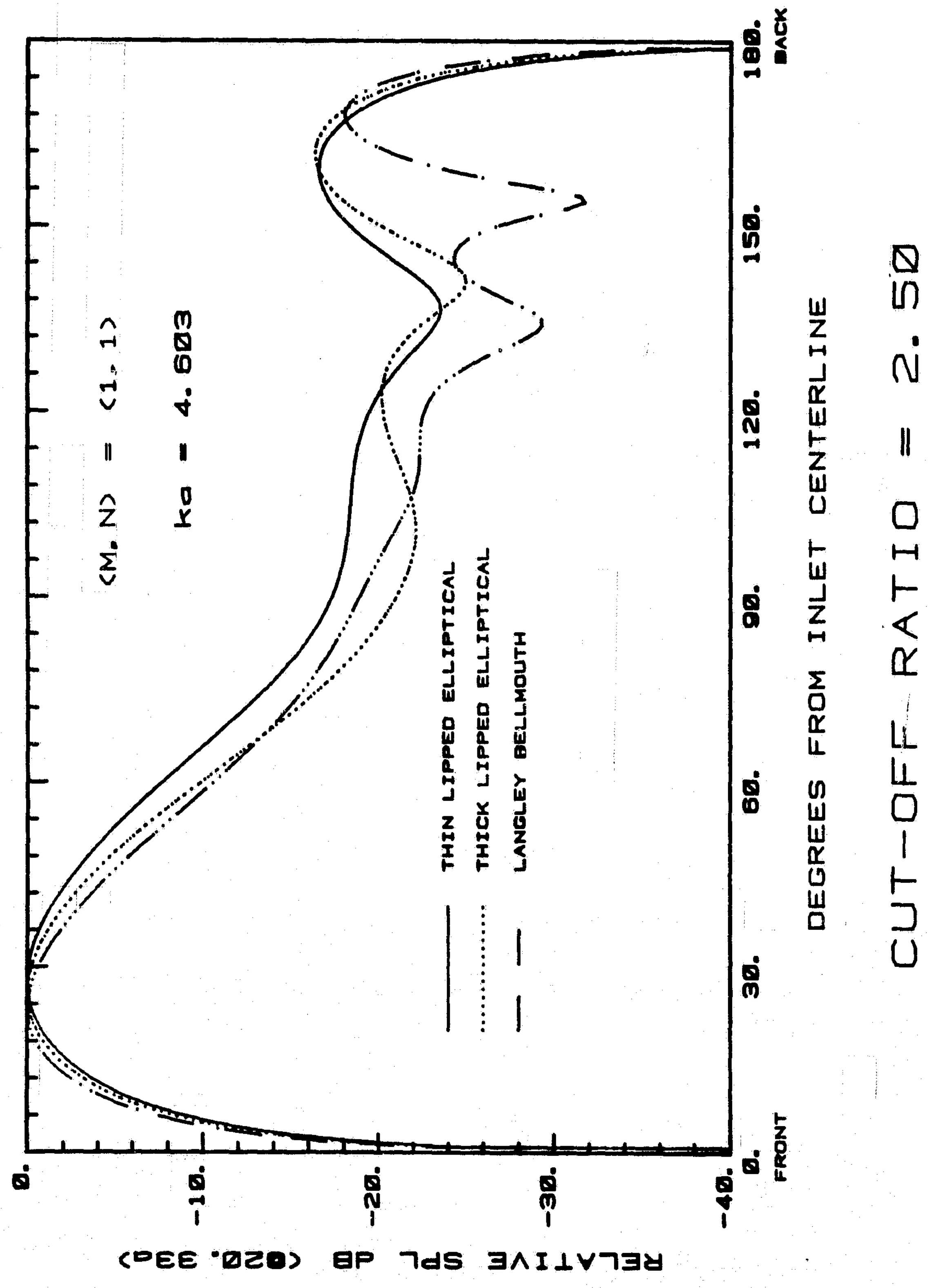


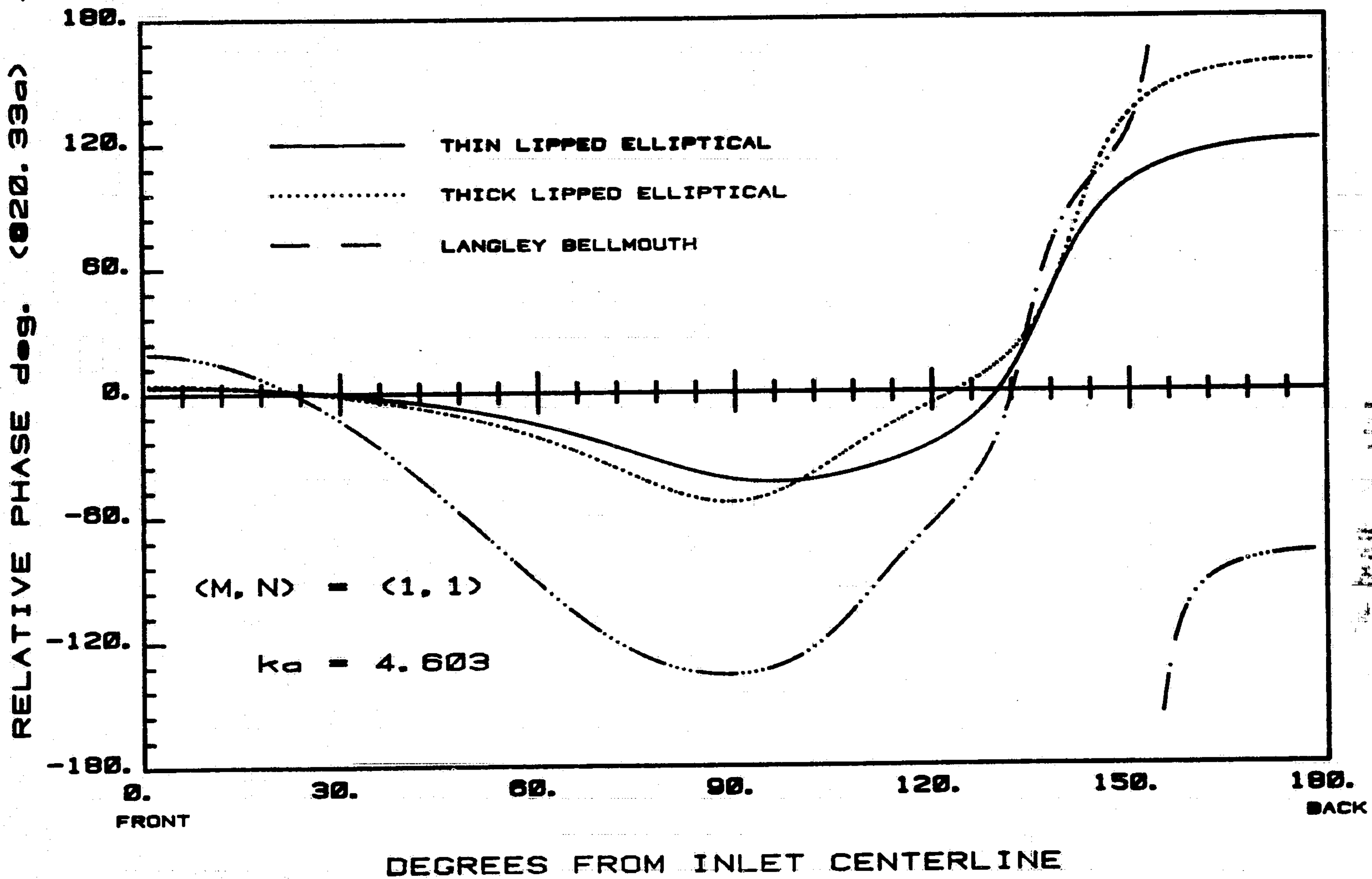
CUT-OFF RATIO = 2.04

Fig. 59n



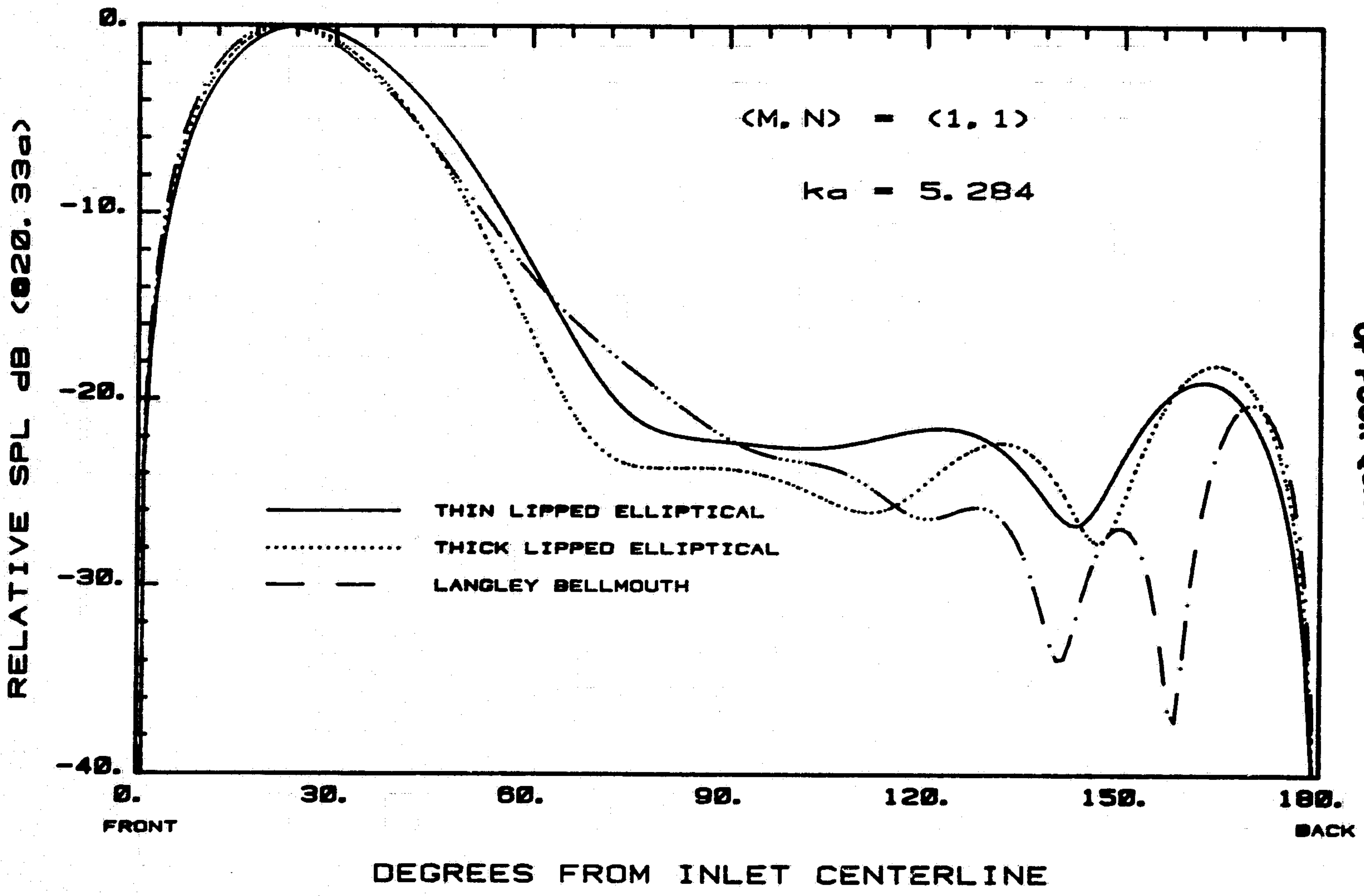
(M, N) = (1, 1)
ka = 4.603
THIN LIPPED ELLIPTICAL
THICK LIPPED ELLIPTICAL
LANGLEY BELLMOUTH
RELATIVE SPL dB (820.33a)
0.
-10.
-20.
-30.
-40.
0. FRONT
30.
60.
90.
120.
150.
180. BACK
DEGREES FROM INLET CENTERLINE
CUT-OFF RATIO = 2.50

Fig. 59o



CUT-OFF RATIO = 2.50

Fig. 59p



CUT-OFF RATIO = 2.87

Fig. 59q

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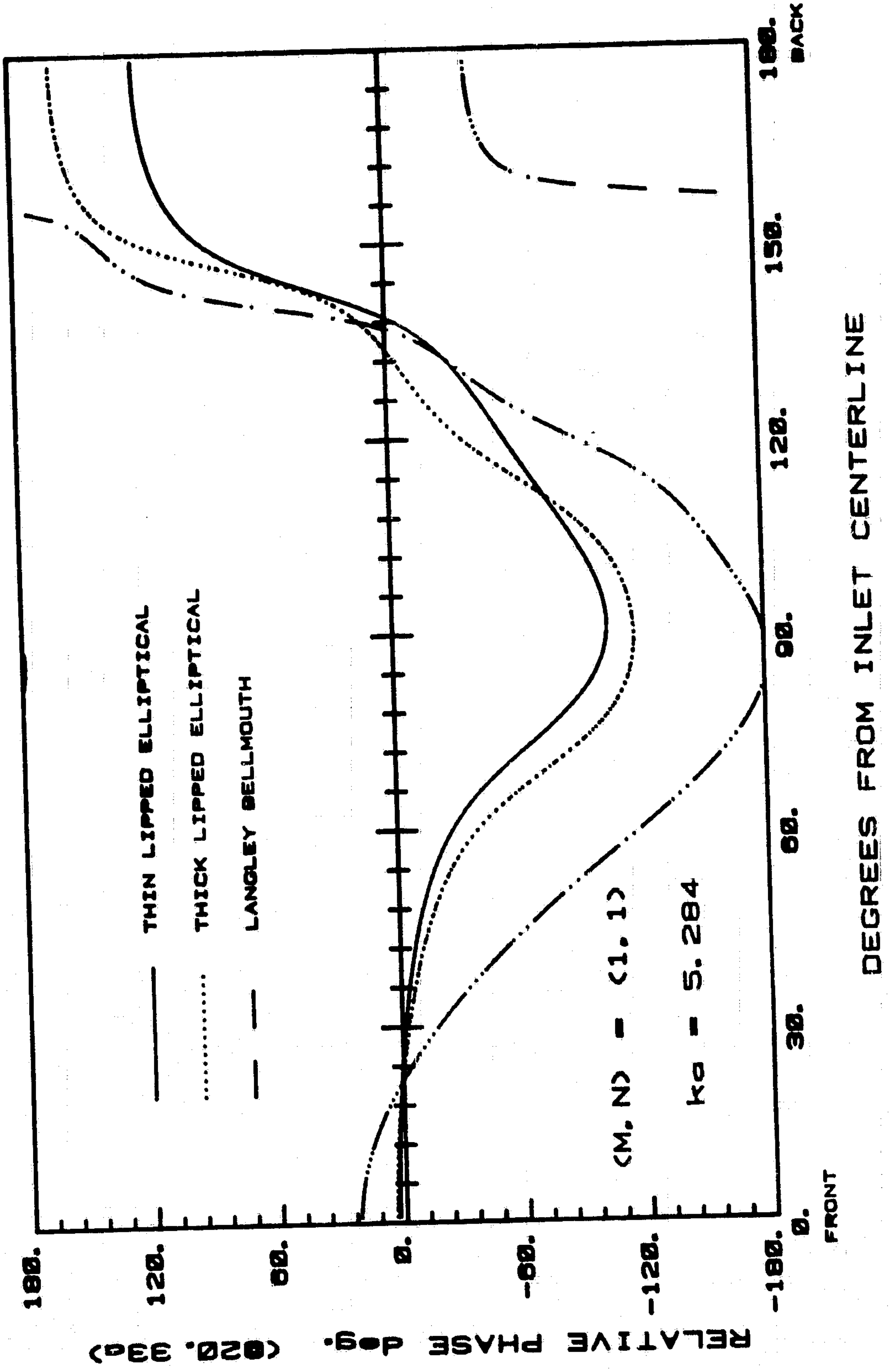

CUT-OFF RATIO = 2.87

Fig. 59r

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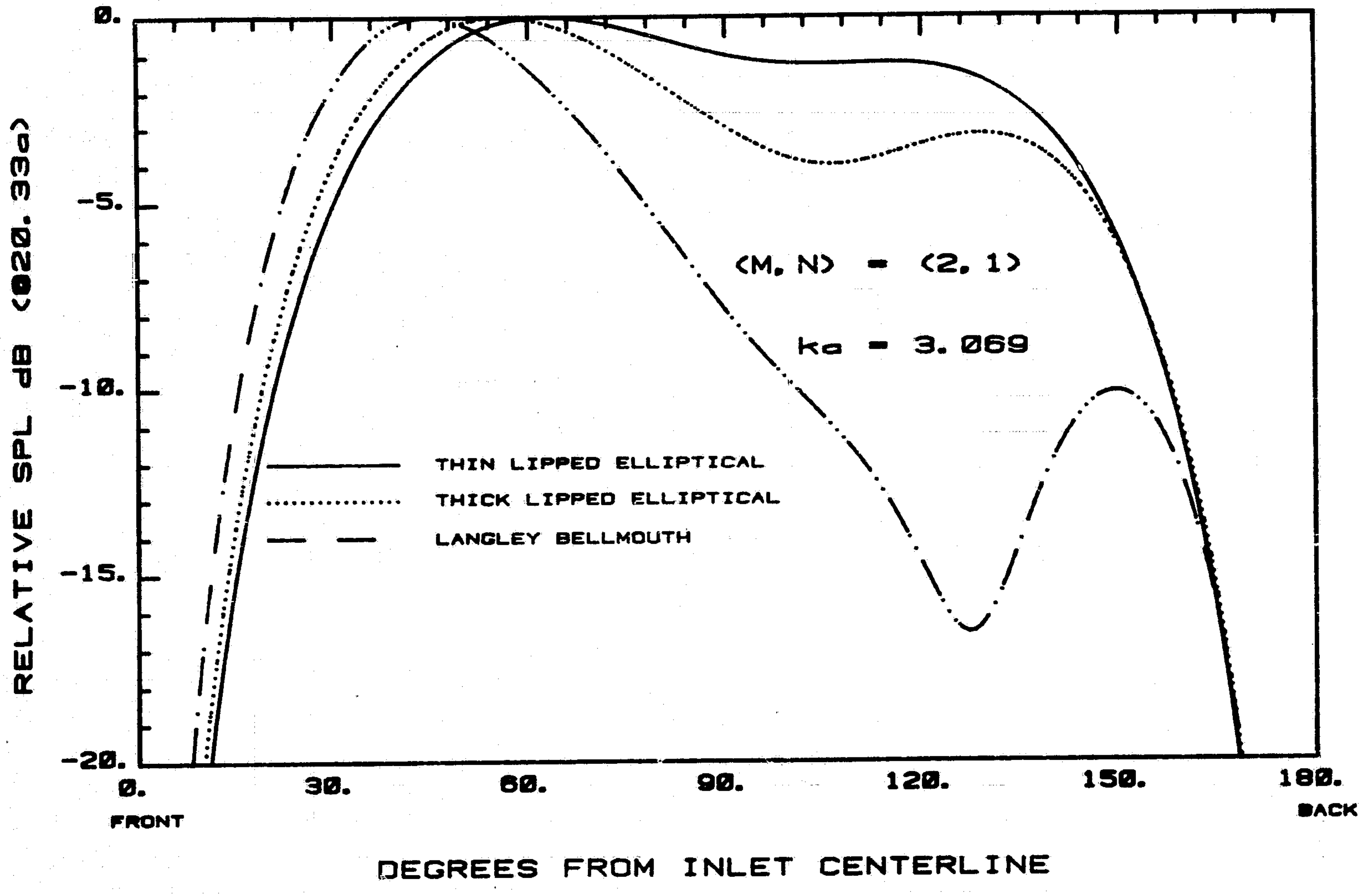

CUT-OFF RATIO = 1.005

Fig. 60a

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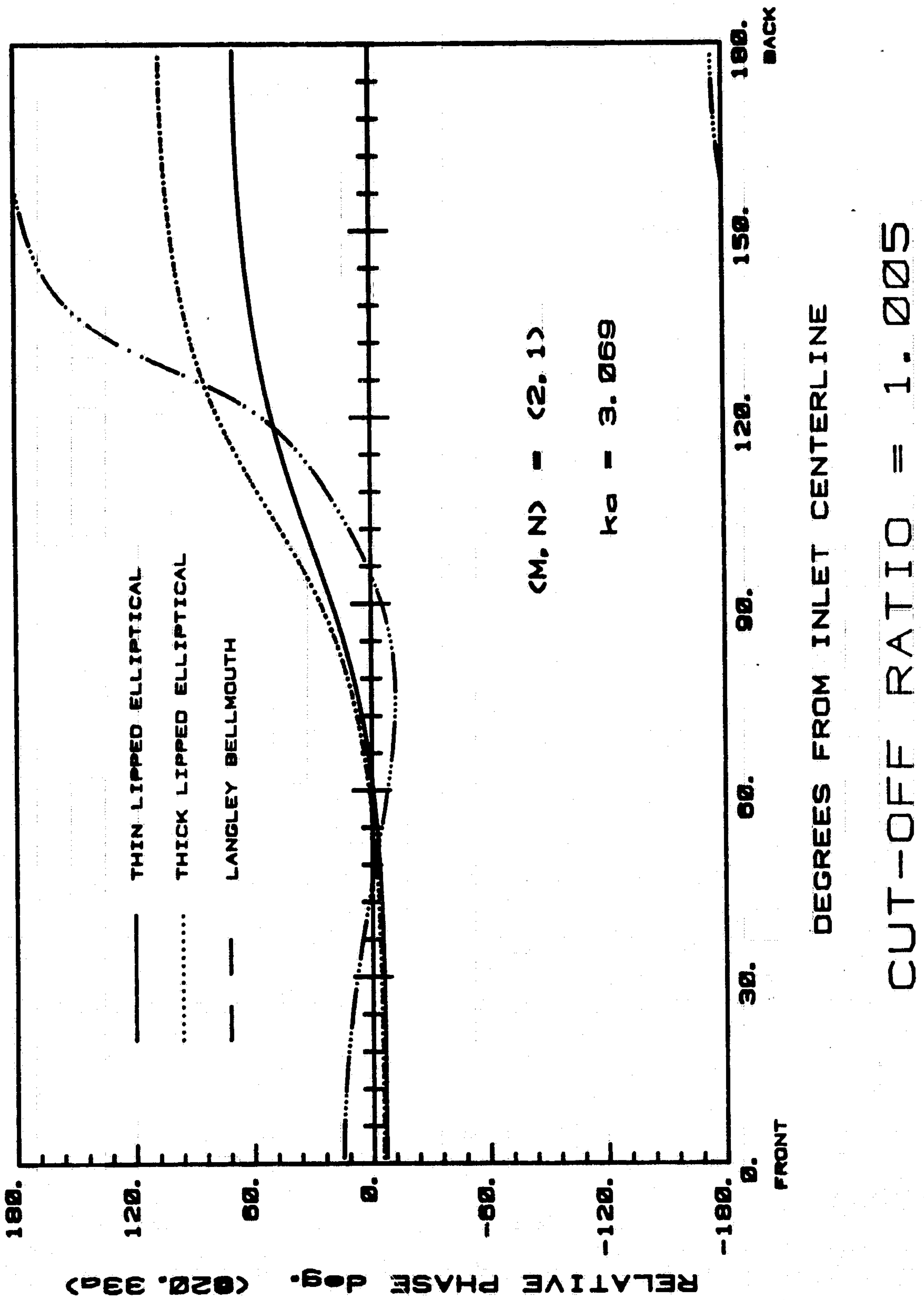

Fig. 60b

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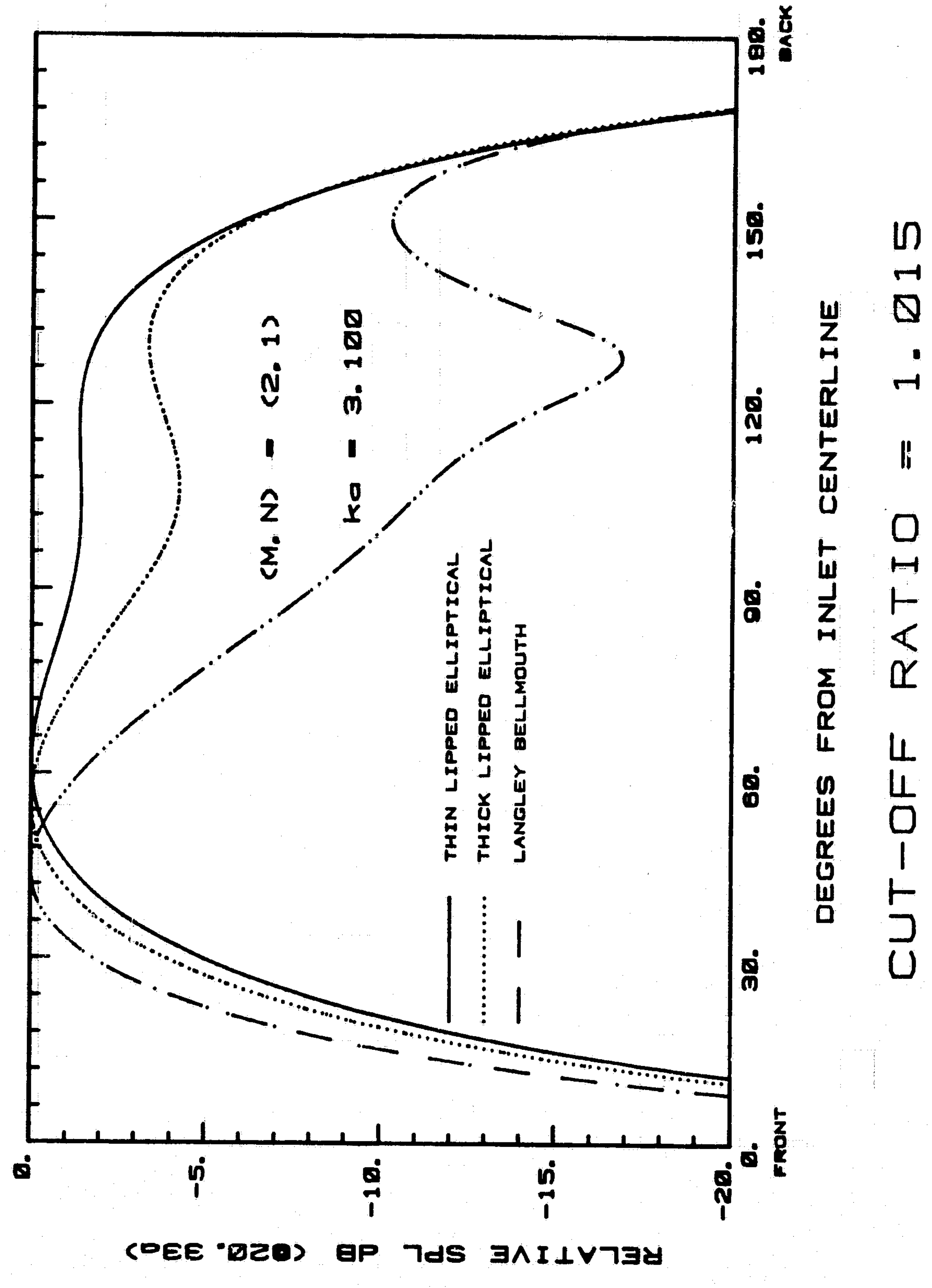


Fig. 60c

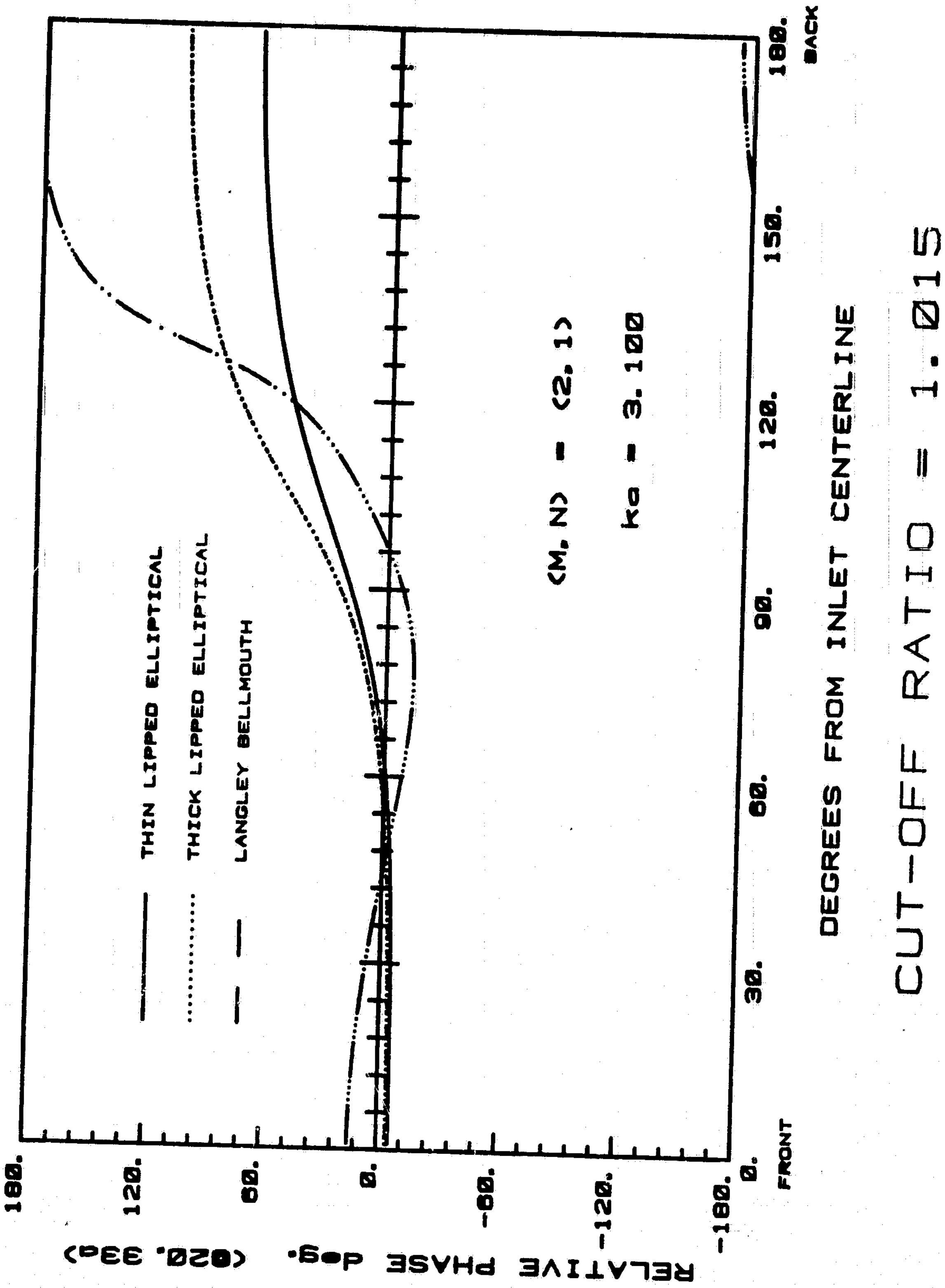
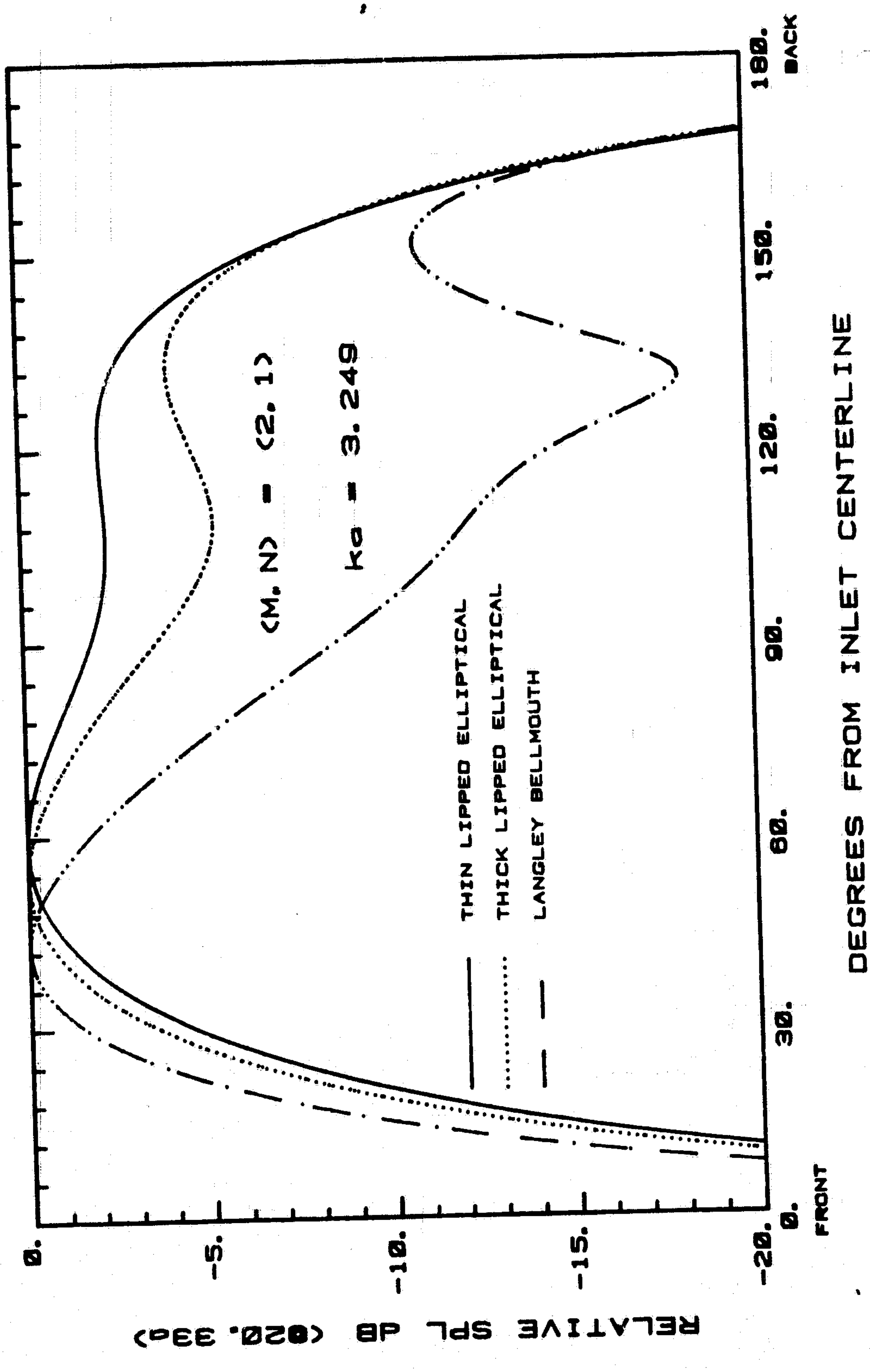

RELATIVE PHASE deg. (Ø2Ø. 33a)
DEGREES FROM INLET CENTERLINE
FRONT
BACK
180.
120.
60.
0.
-60.
-120.
-180.
30.
90.
150.
THIN LIPPED ELLIPTICAL
THICK LIPPED ELLIPTICAL
LANGLEY BELLMOUTH
(M, N) = (2, 1)
ka = 3.100
CUT-OFF RATIO = 1.Ø15

Fig. 60d



CUT-OFF RATIO = 1.064

Fig. 60e

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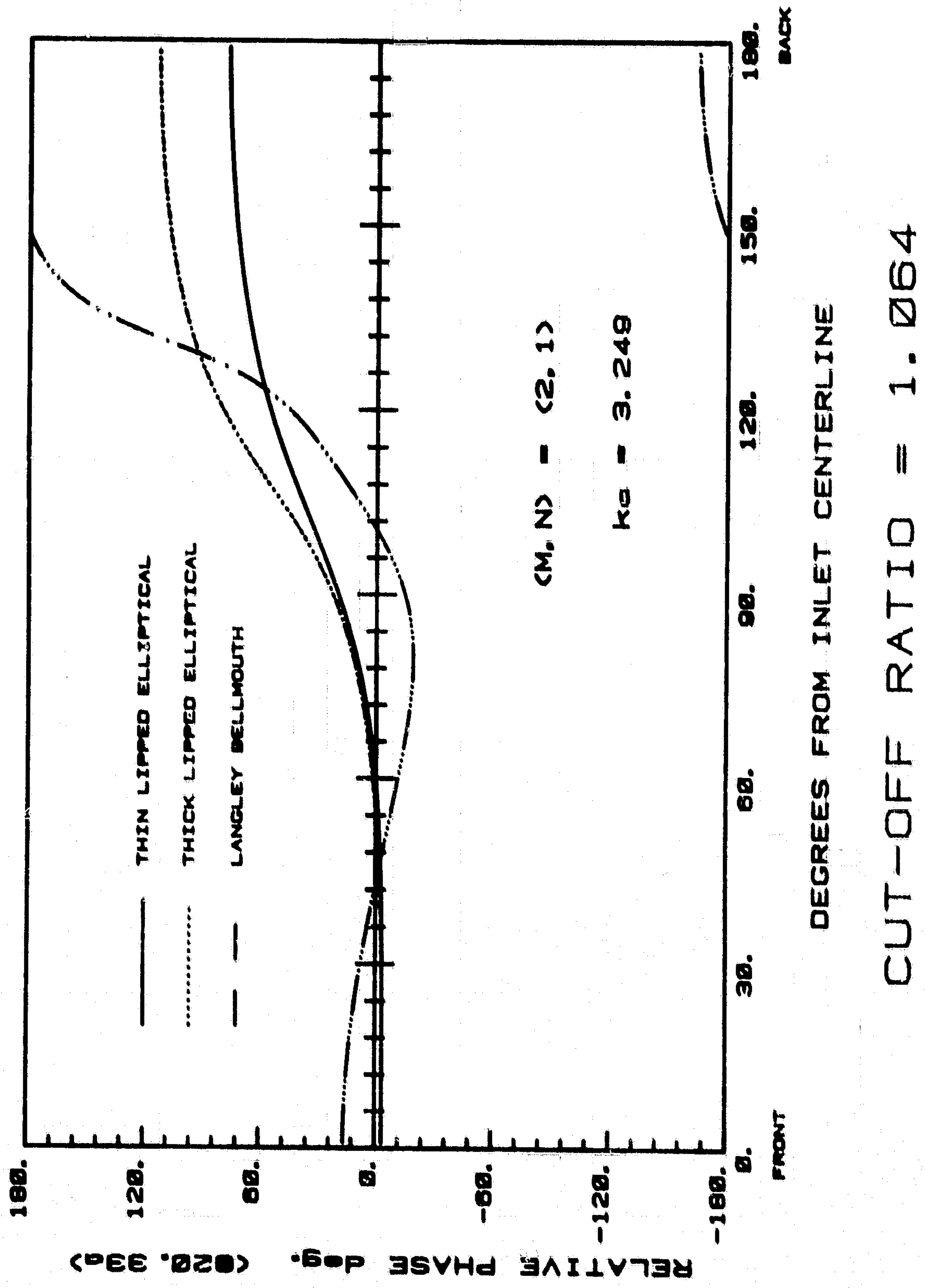

Fig. 60f

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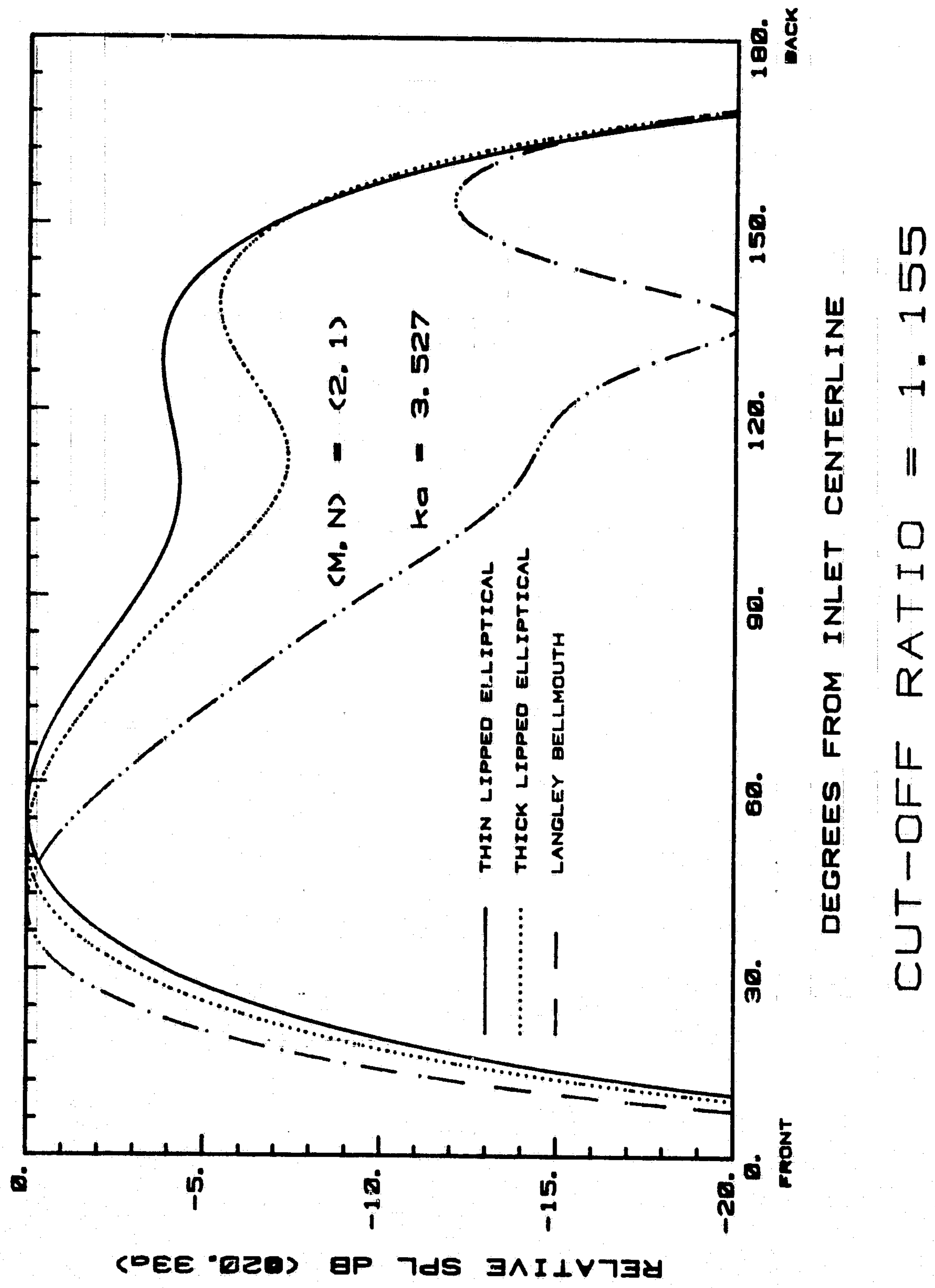

Fig. 60g

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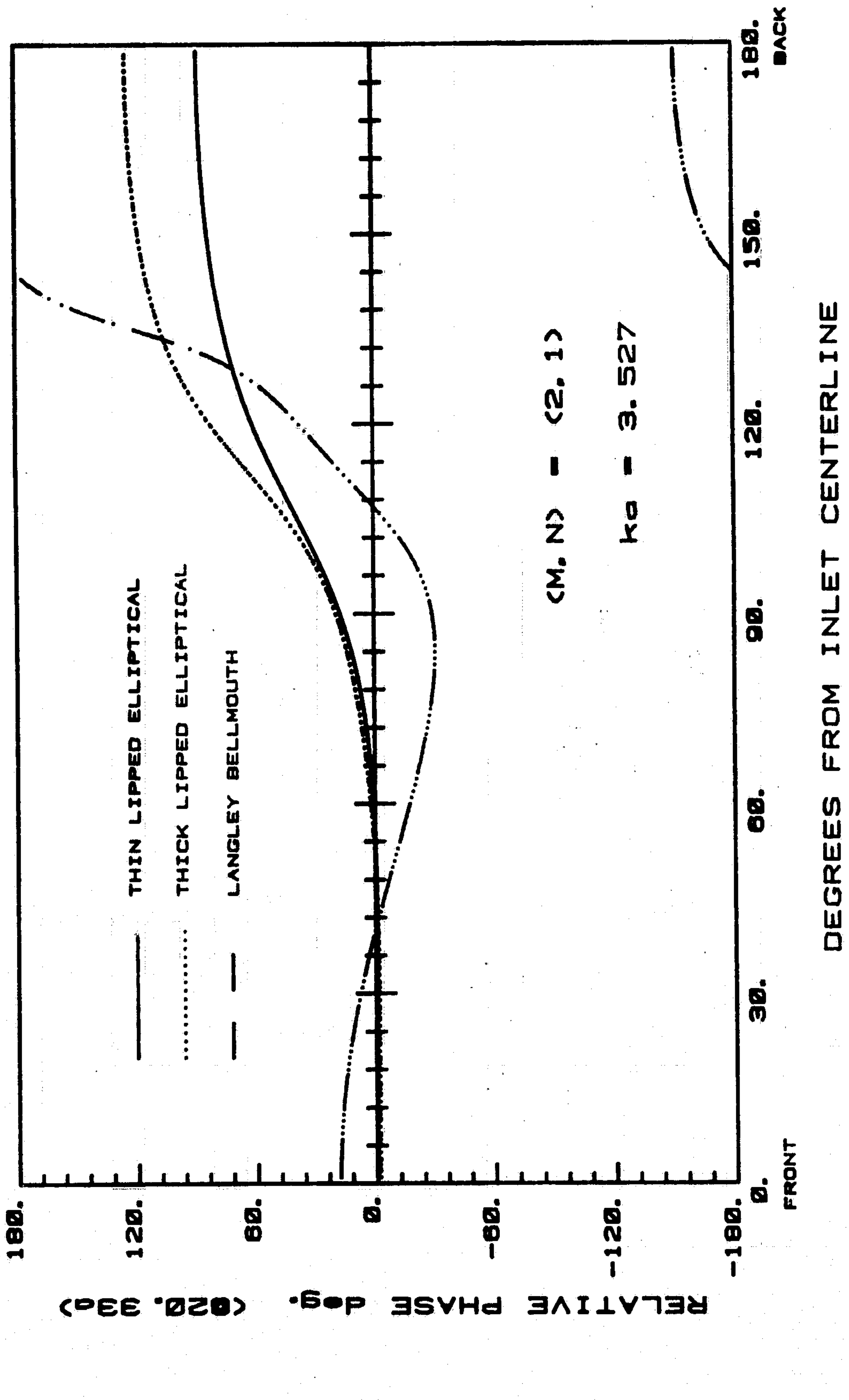
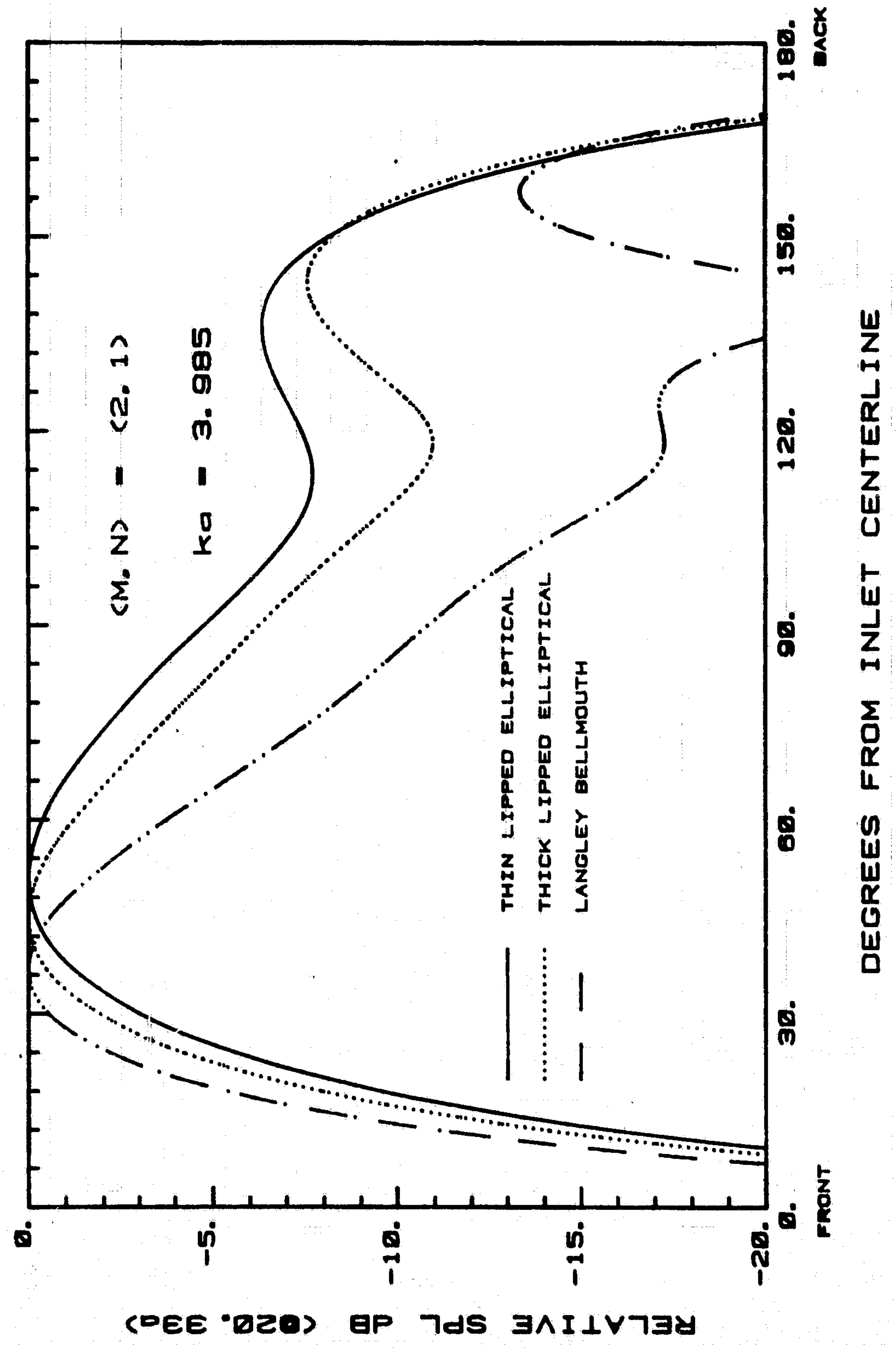


CUT-OFF RATIO = 1.155

Fig. 60h



CUT-OFF RATIO = 1.305

Fig. 60i

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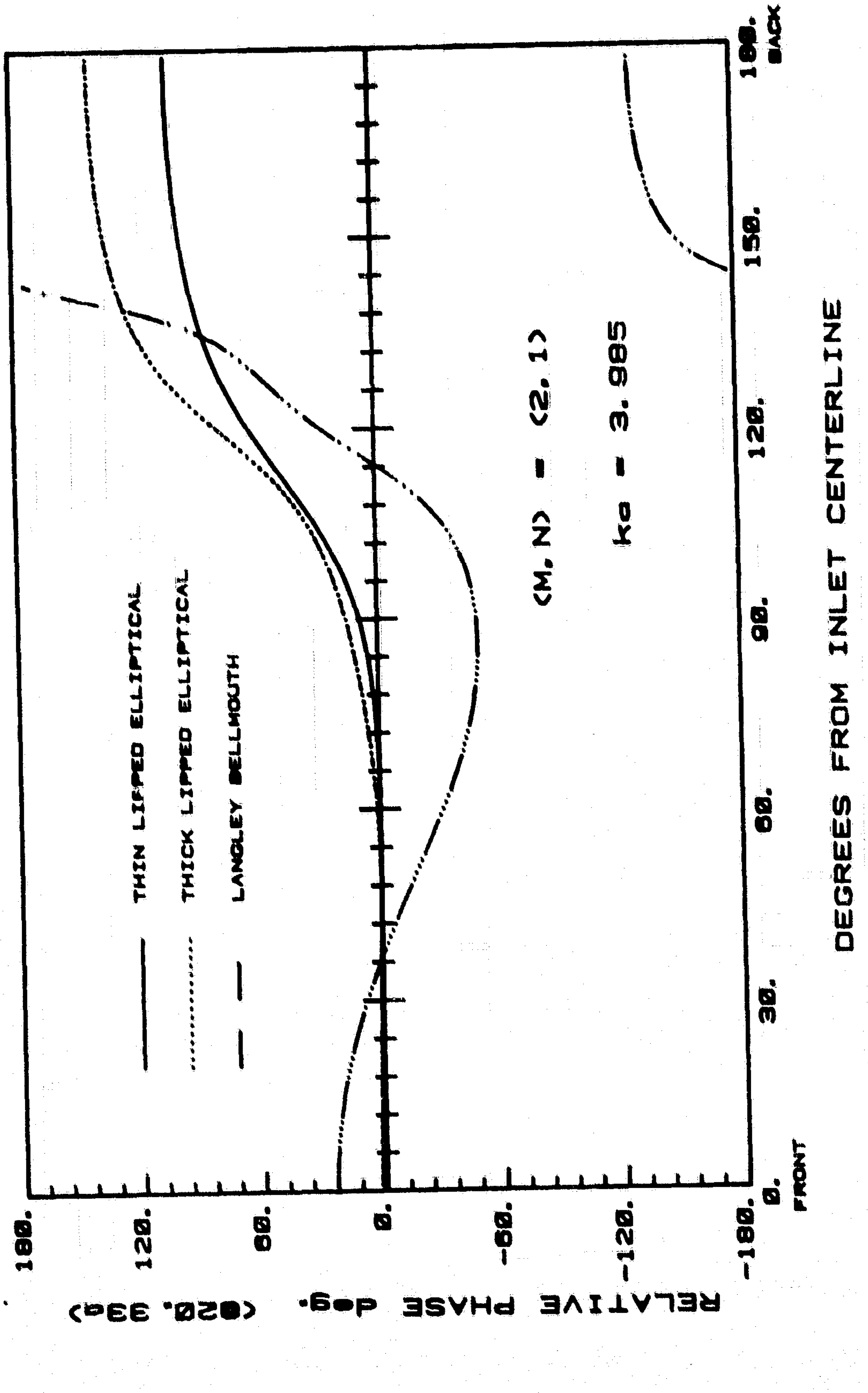
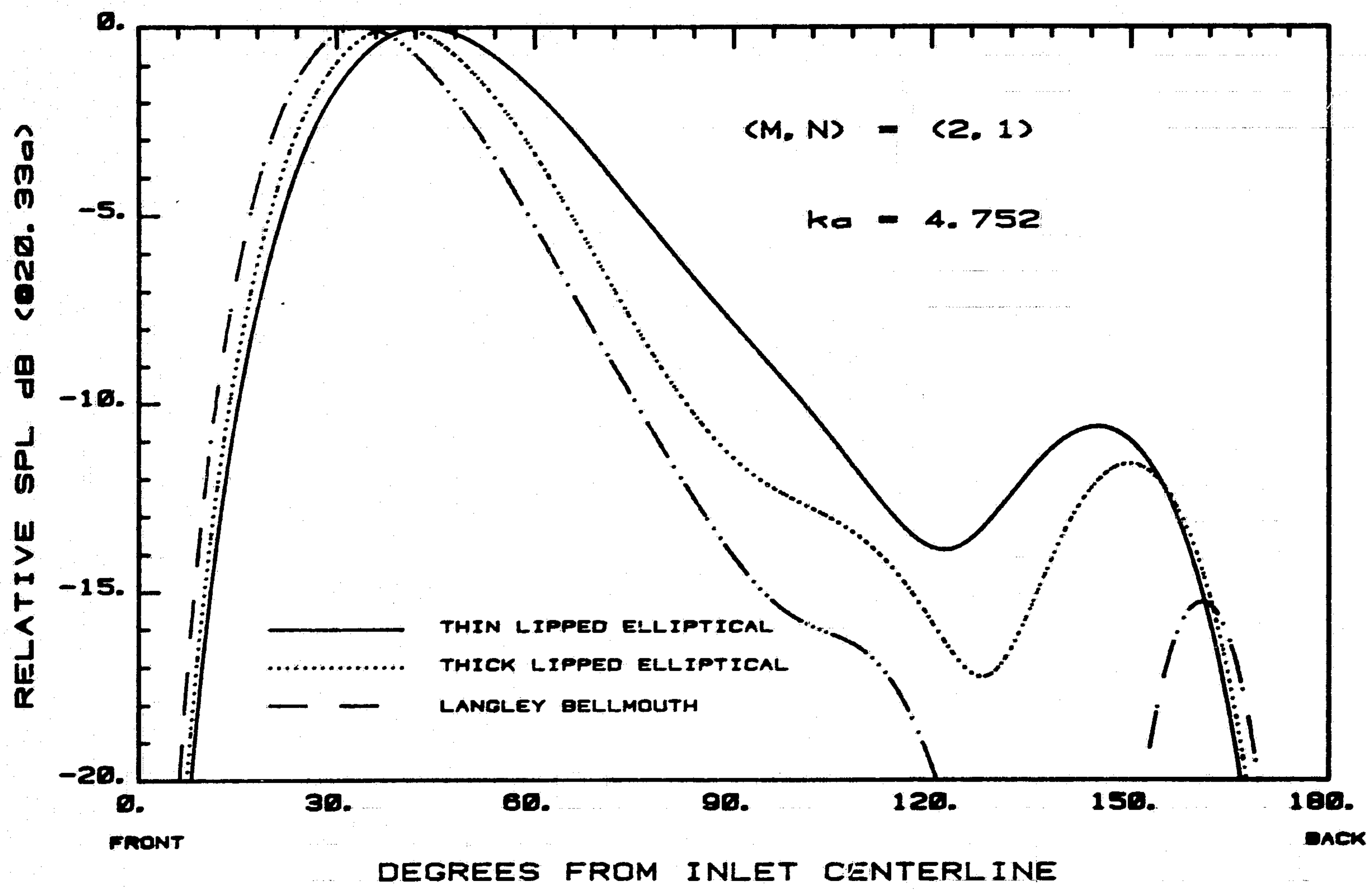


CUT-OFF RATIO = 1.305

Fig. 60j



CUT-OFF RATIO = 1.556

Fig. 60k

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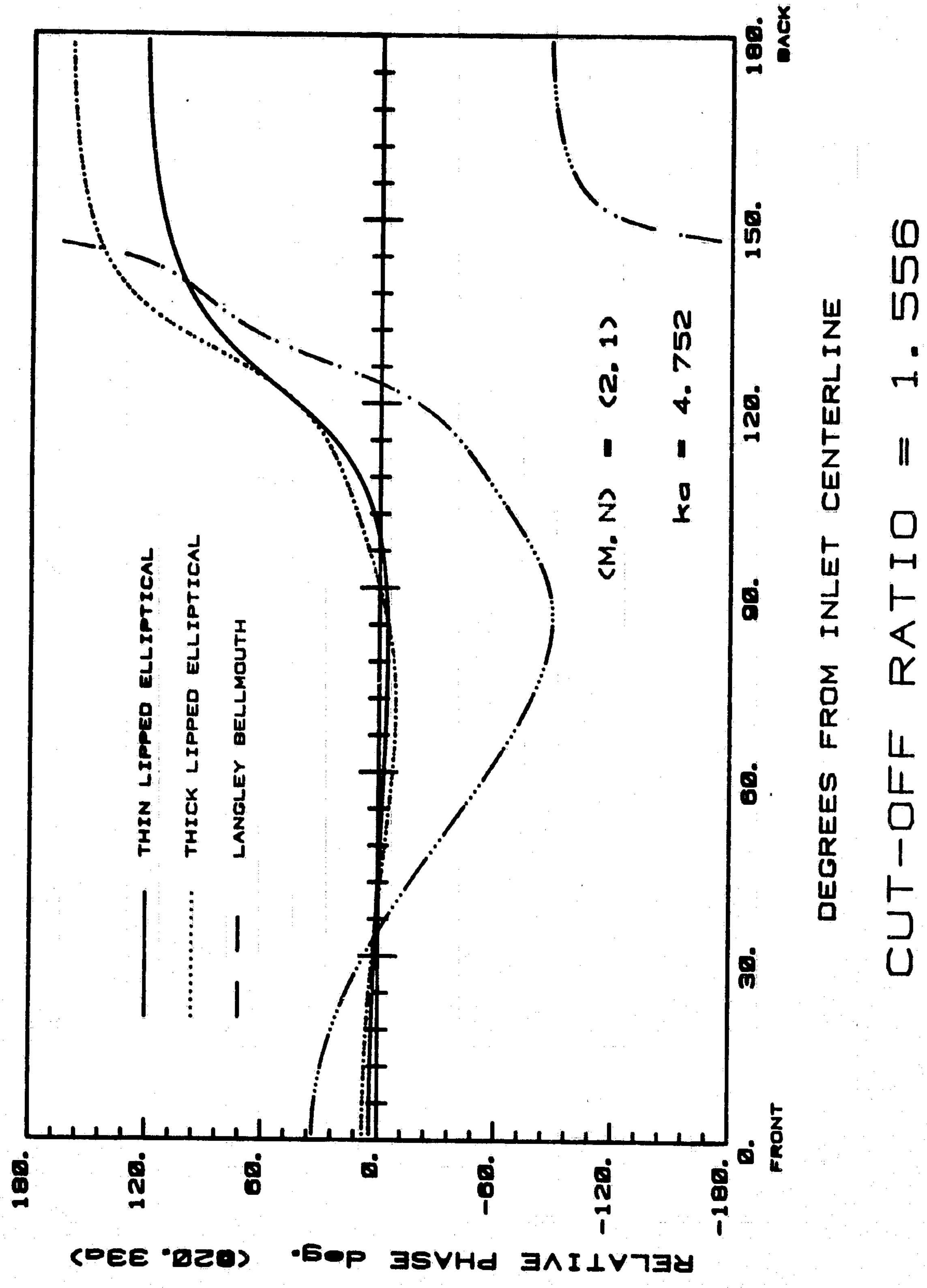

Fig. 601

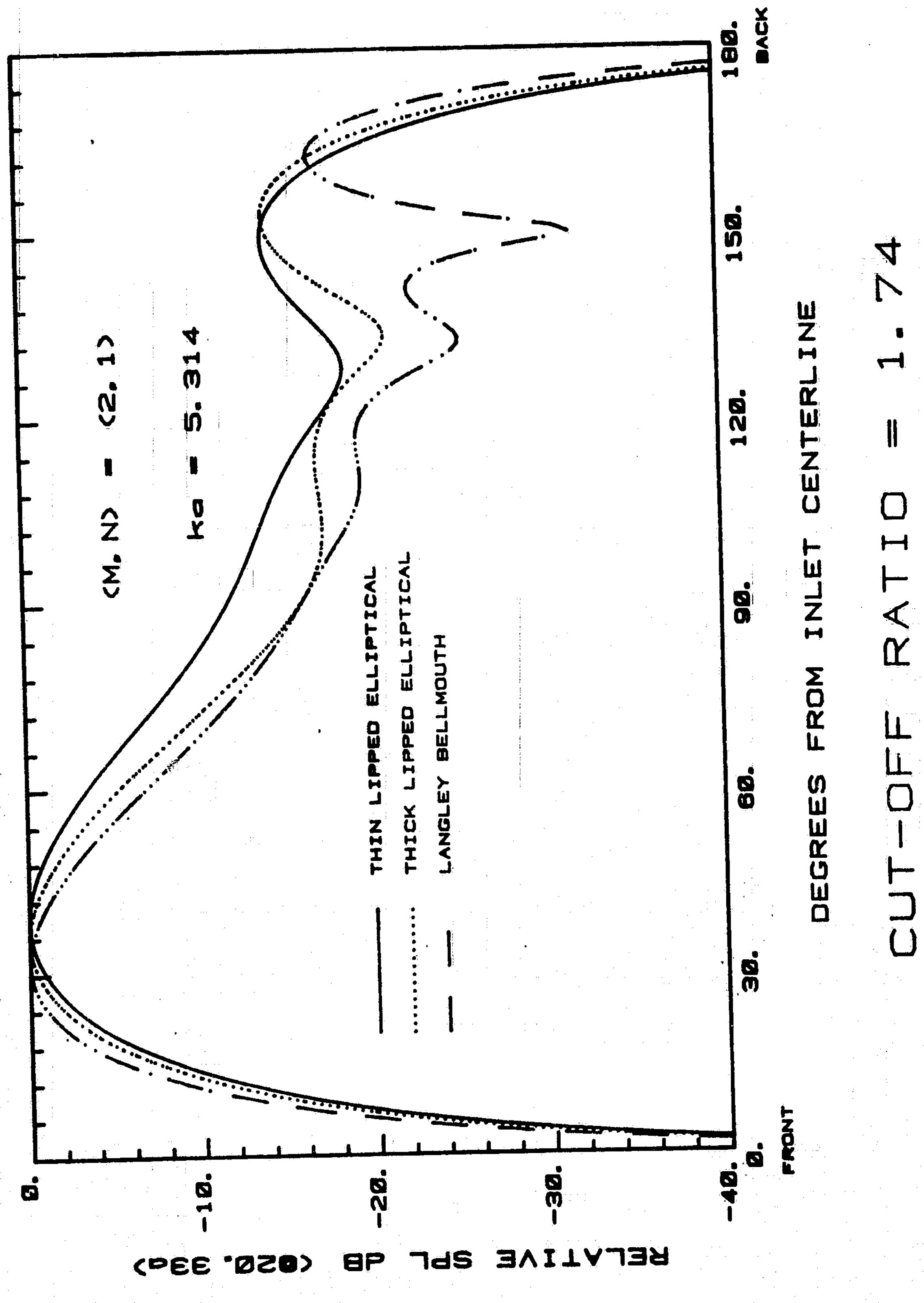
(M, N) = (2, 1)
ka = 5.314
THIN LIPPED ELLIPTICAL
THICK LIPPED ELLIPTICAL
LANGLEY BELLMOUTH
RELATIVE SPL dB (@20.33d)
0.
-10.
-20.
-30.
-40.
0.
30.
60.
90.
120.
150.
180.
FRONT
BACK
DEGREES FROM INLET CENTERLINE
CUT-OFF RATIO = 1.74

Fig. 60m

ORIGINAL PAGE IS
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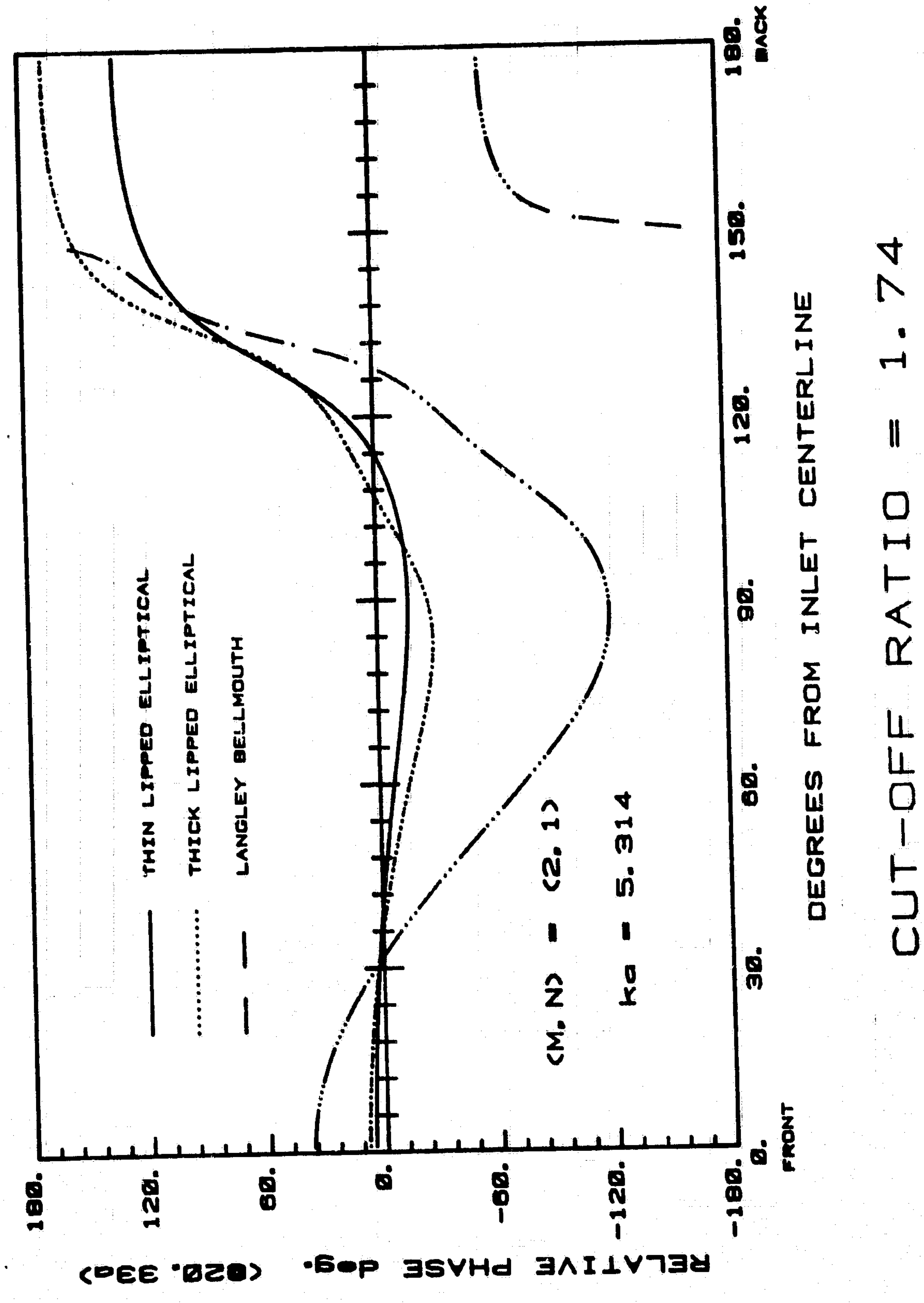
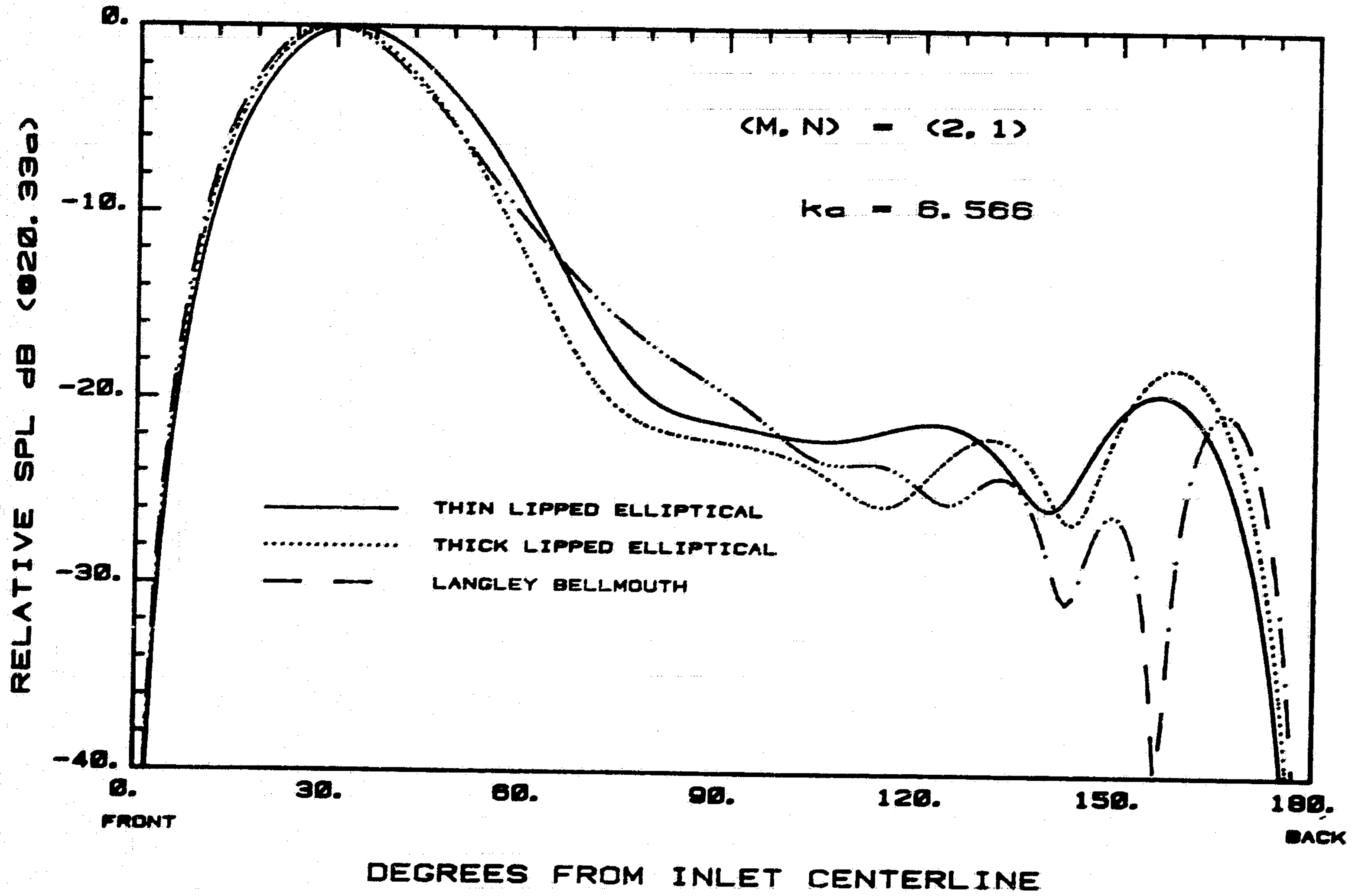


Fig. 60n



CUT-OFF RATIO = 2.15

Fig. 60o

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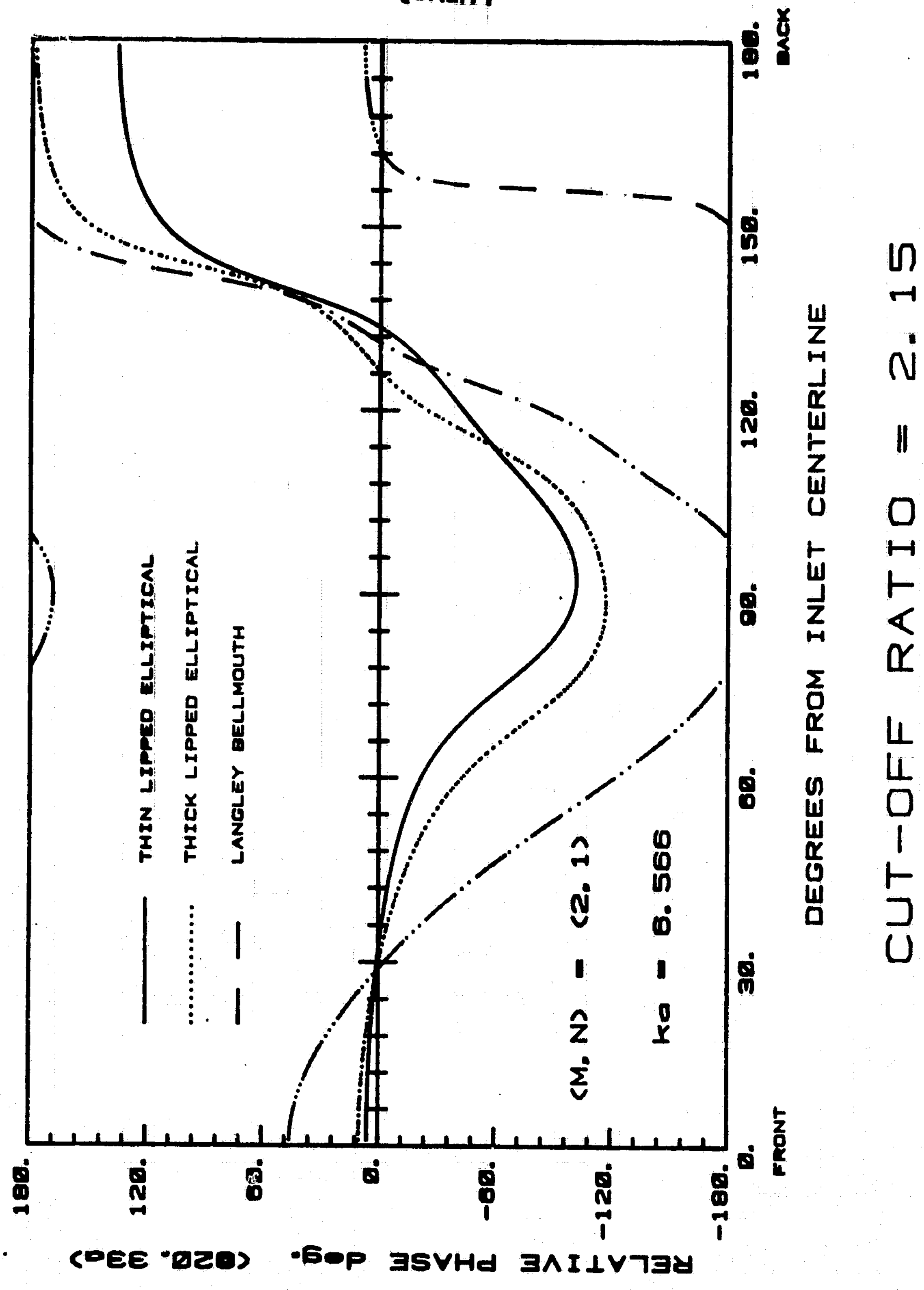
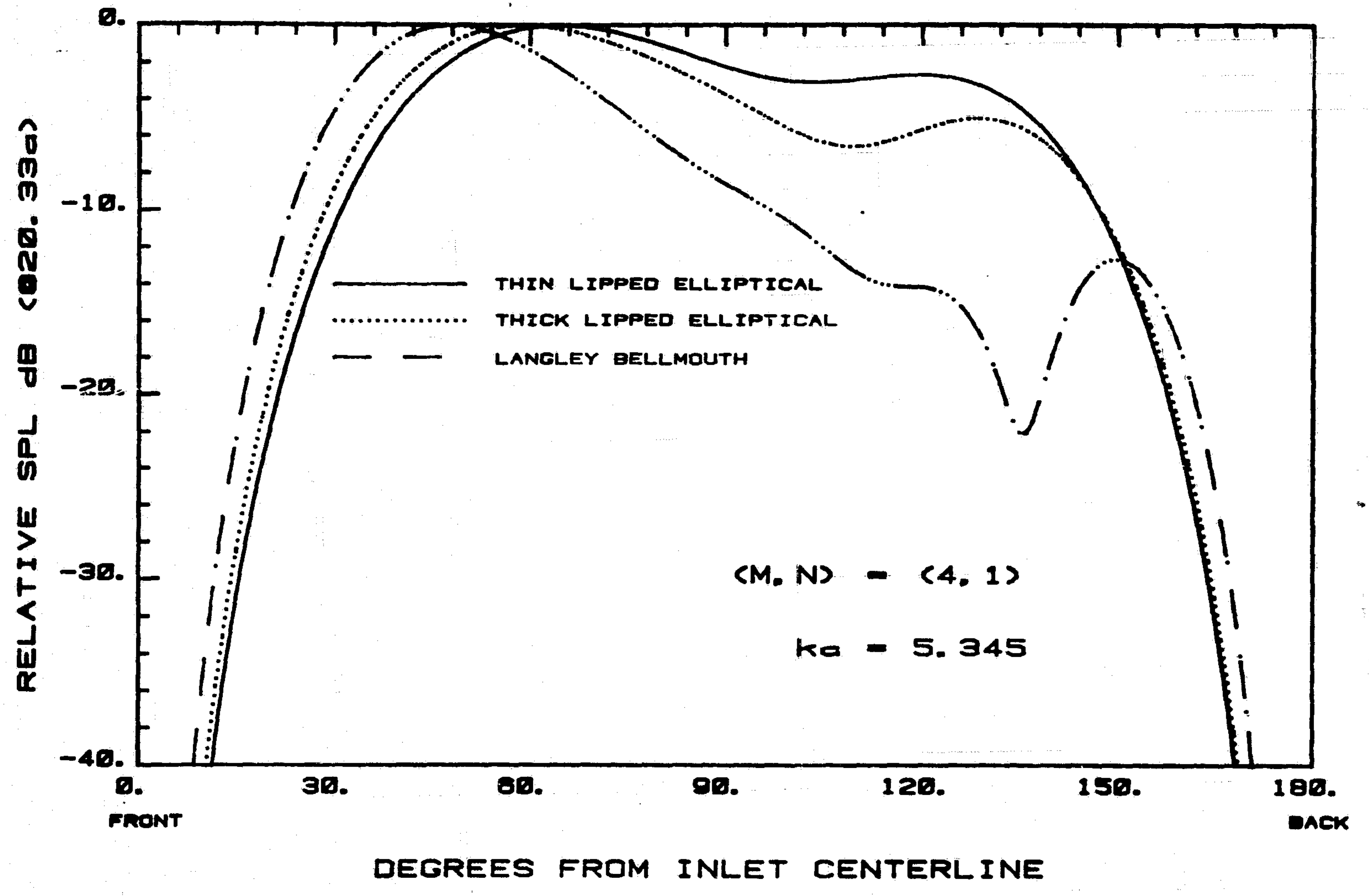


Fig. 60p



CUT-OFF RATIO = 1.005

Fig. 61a

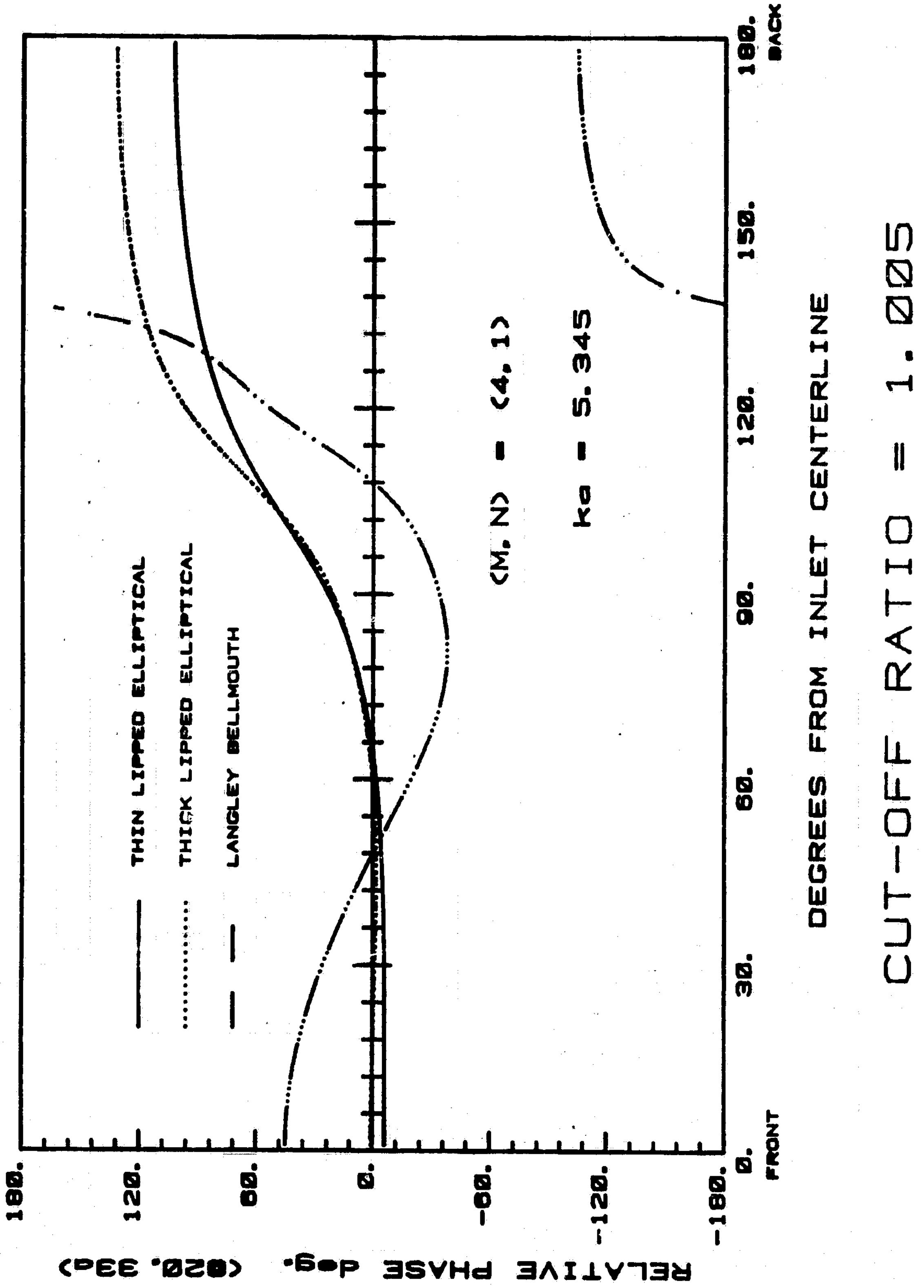
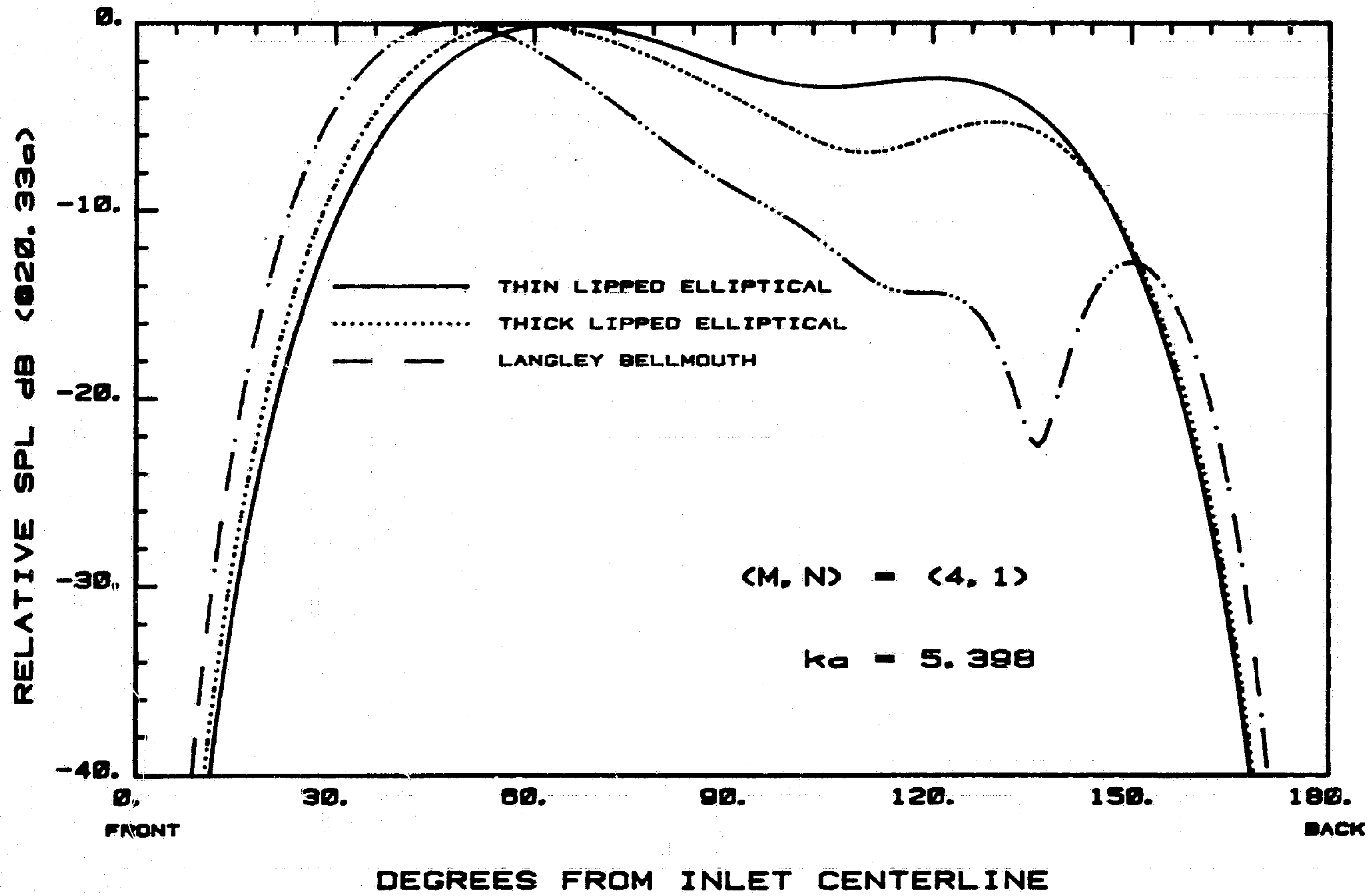

THIN LIPPED ELLIPTICAL
THICK LIPPED ELLIPTICAL
LANGLEY BELLMOUTH
(M, N) = (4, 1)
ka = 5.345
RELATIVE PHASE deg. (020, 33d)
180.
120.
60.
0.
-60.
-120.
-180.
0.
FRONT
30.
60.
90.
120.
150.
180.
BACK
DEGREES FROM INLET CENTERLINE
CUT-OFF RATIO = 1.005

Fig. 61b



CUT-OFF RATIO = 1.015

Fig. 61c

ORIGINAL PAGE IS
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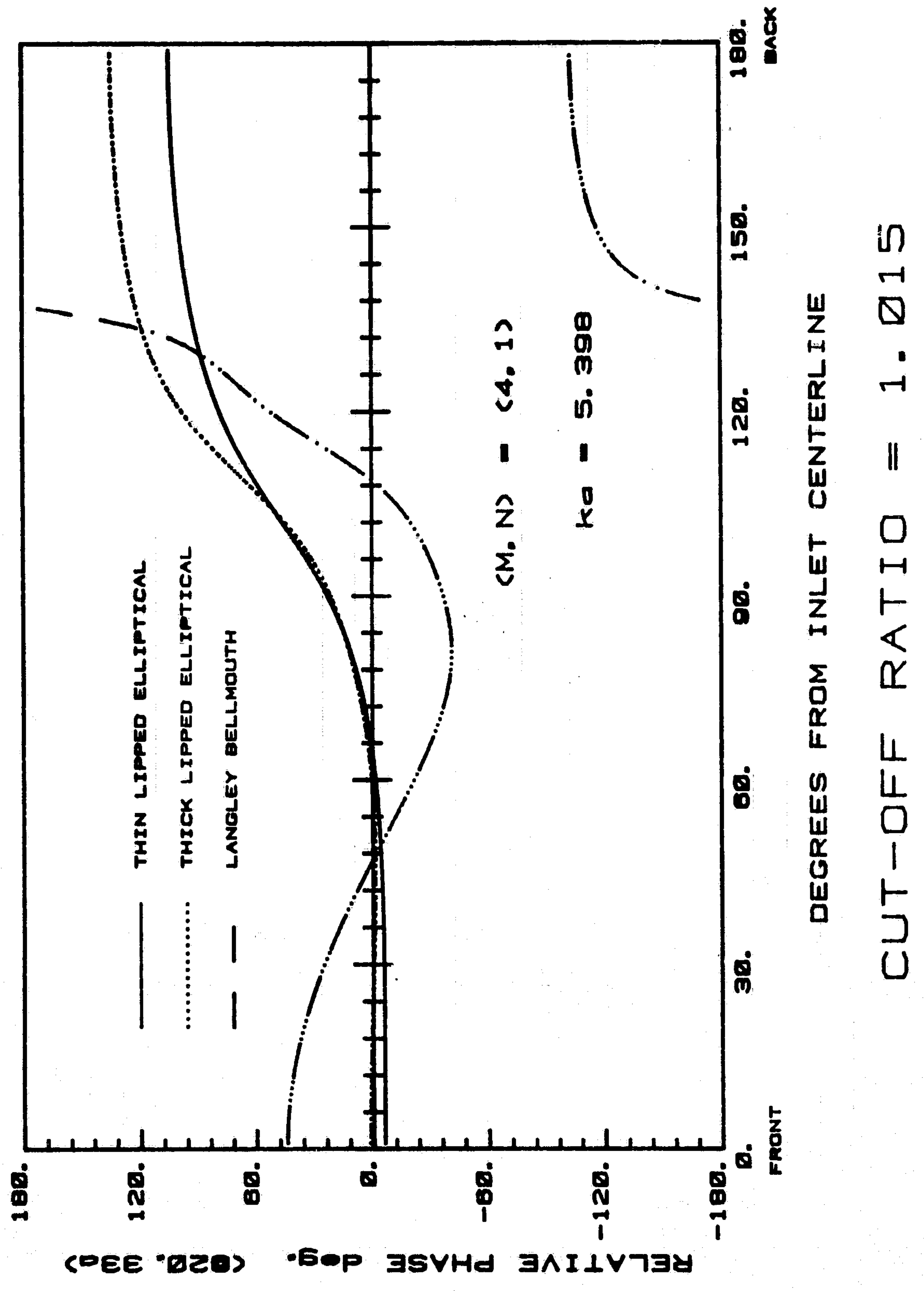

Fig. 61d

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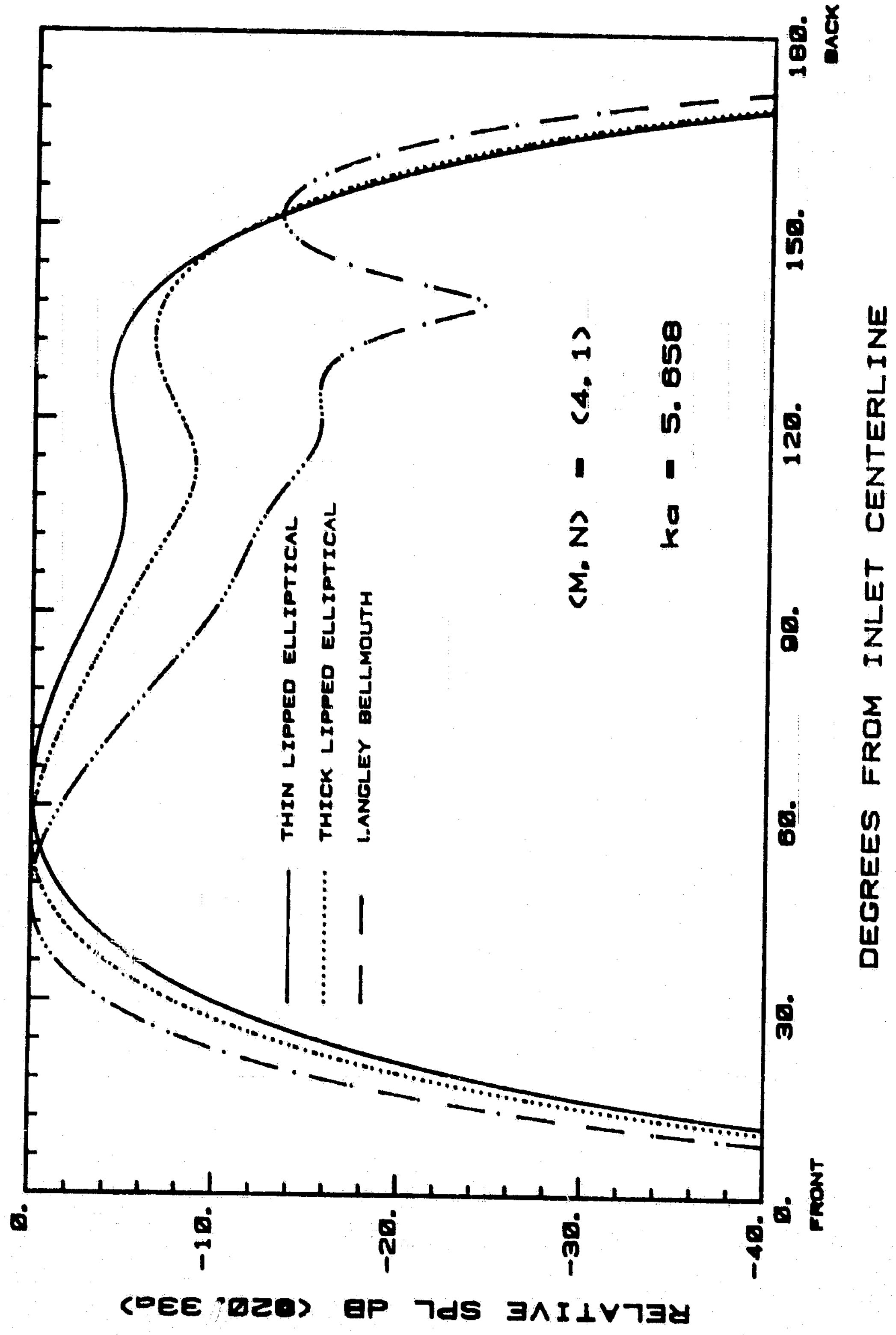

CUT-OFF RATIO = 1.064

Fig. 61e

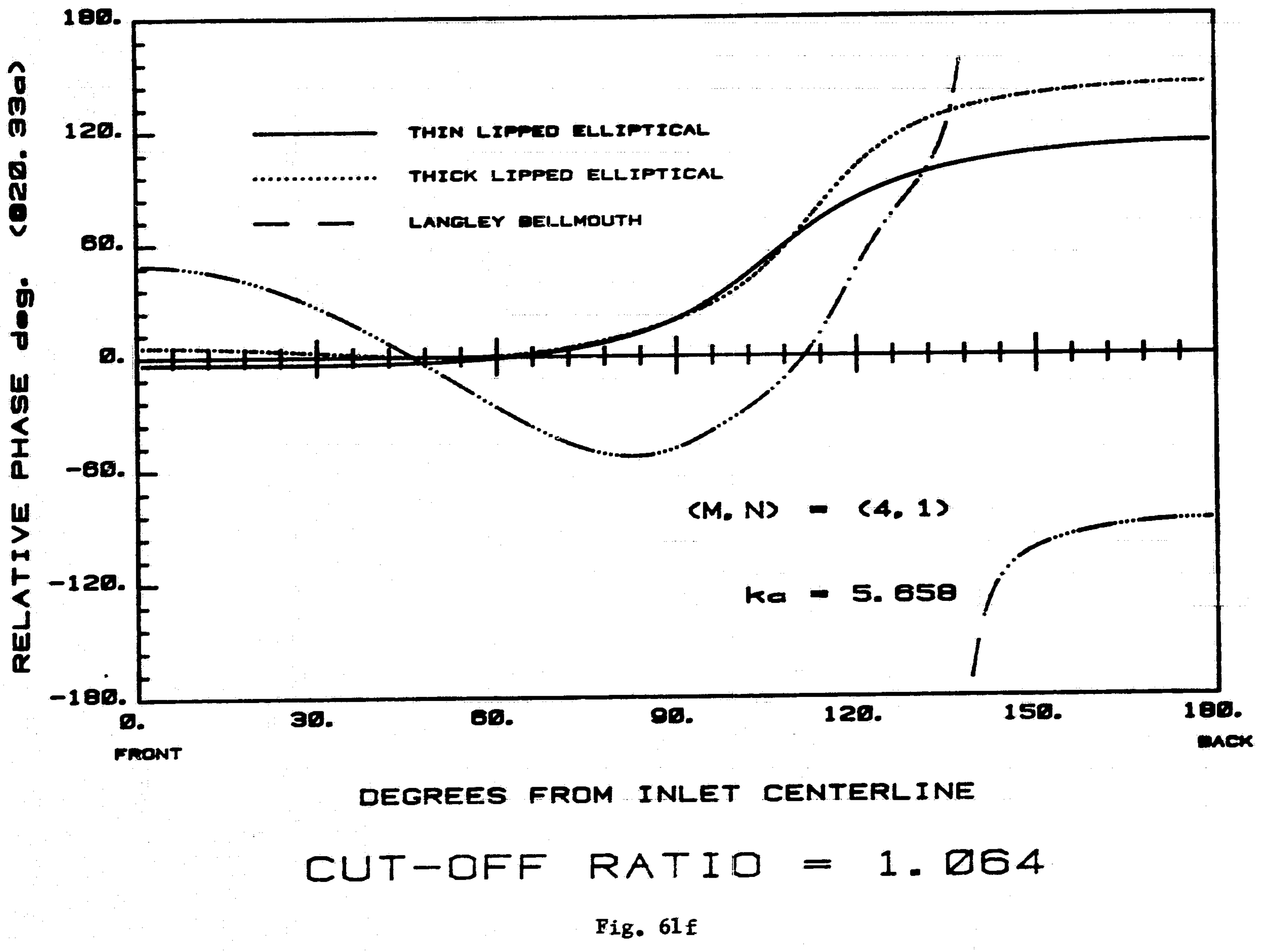
180.
120.
60.
0.
-60.
-120.
-180.
RELATIVE PHASE deg. (020.33a)
THIN LIPPED ELLIPTICAL
THICK LIPPED ELLIPTICAL
LANGLEY BELLMOUTH
(M, N) = (4, 1)
ka = 5.658
0.
FRONT
30.
60.
90.
120.
150.
180.
BACK
DEGREES FROM INLET CENTERLINE
CUT-OFF RATIO = 1.064

Fig. 61f

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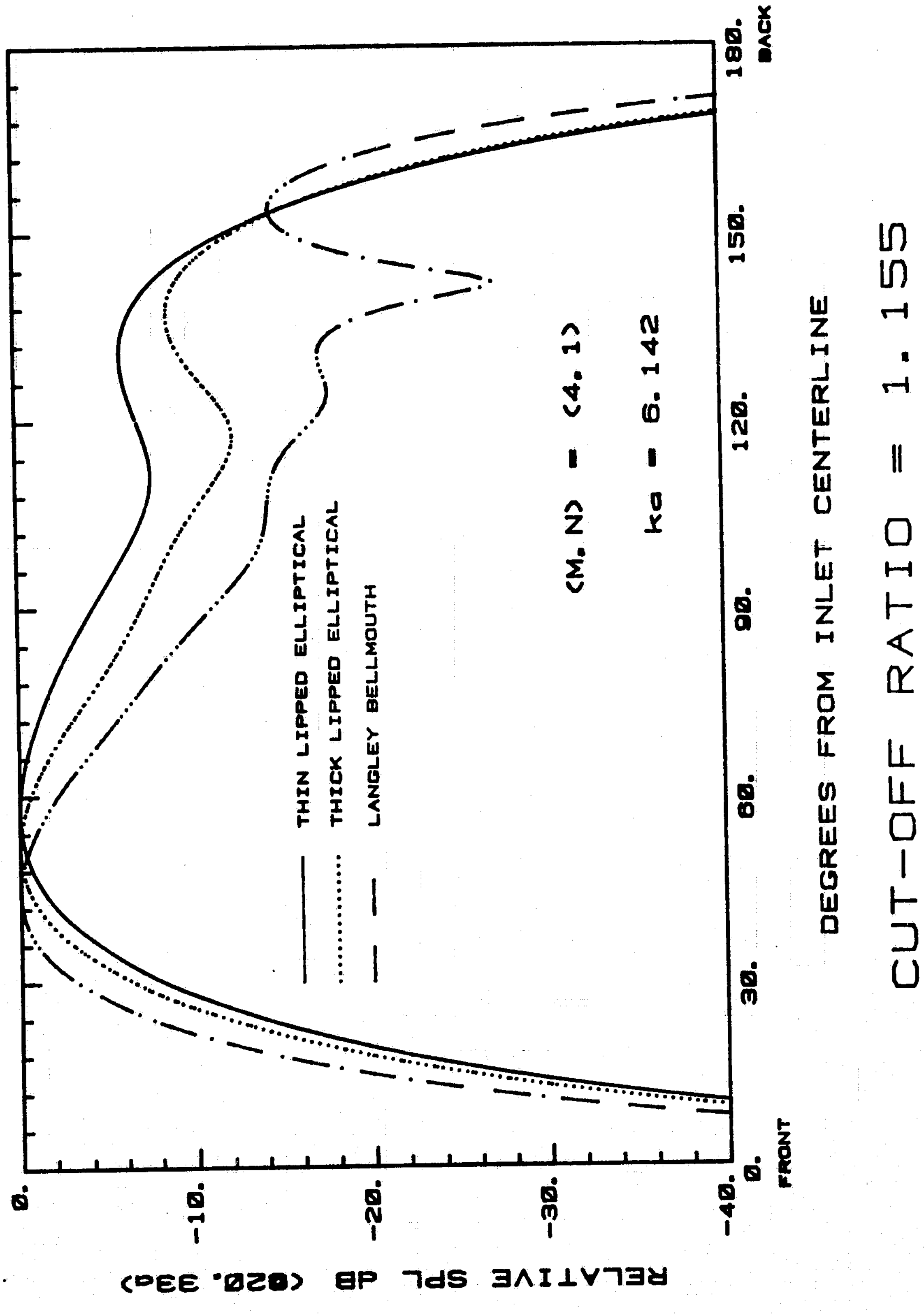
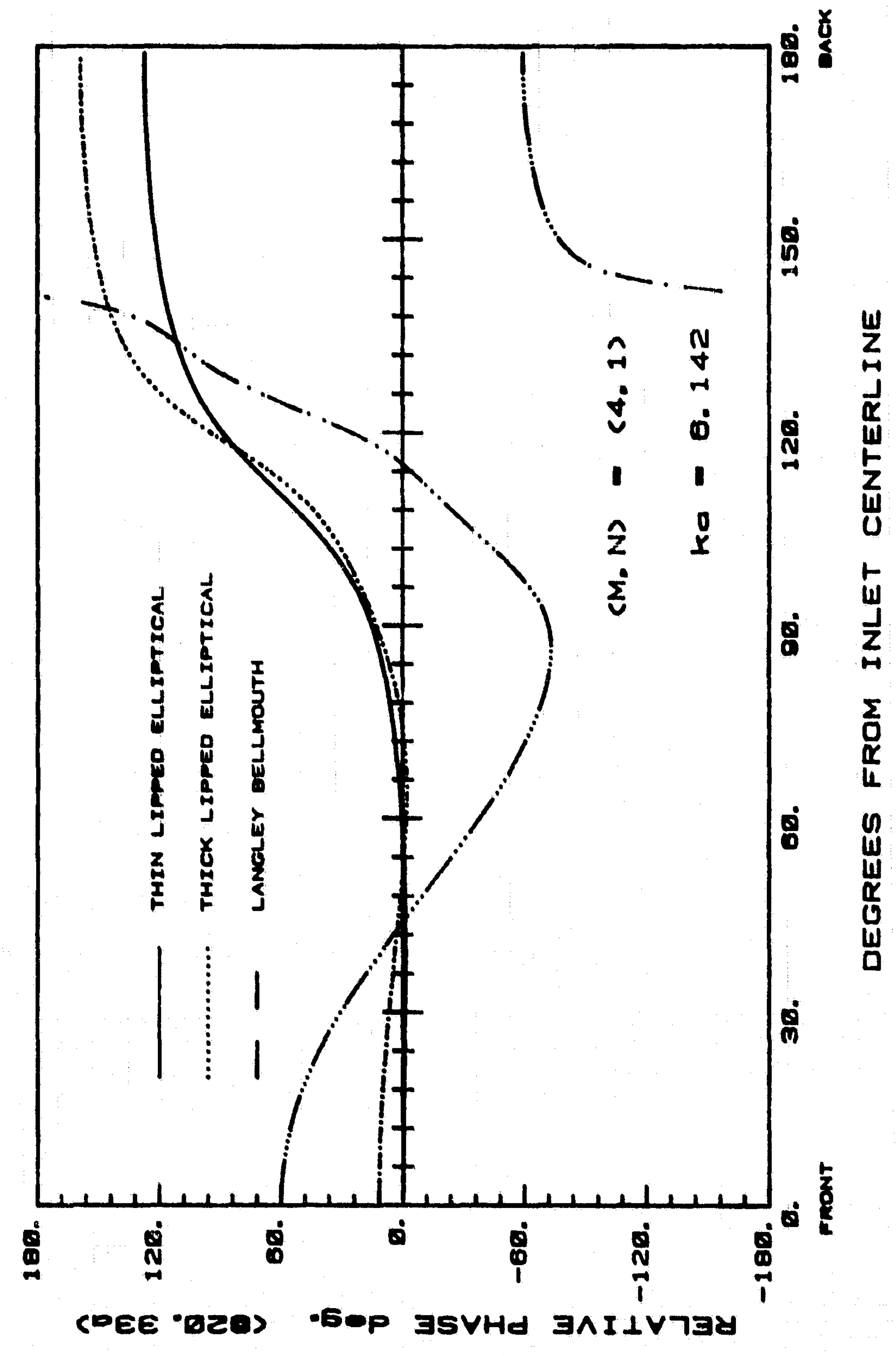
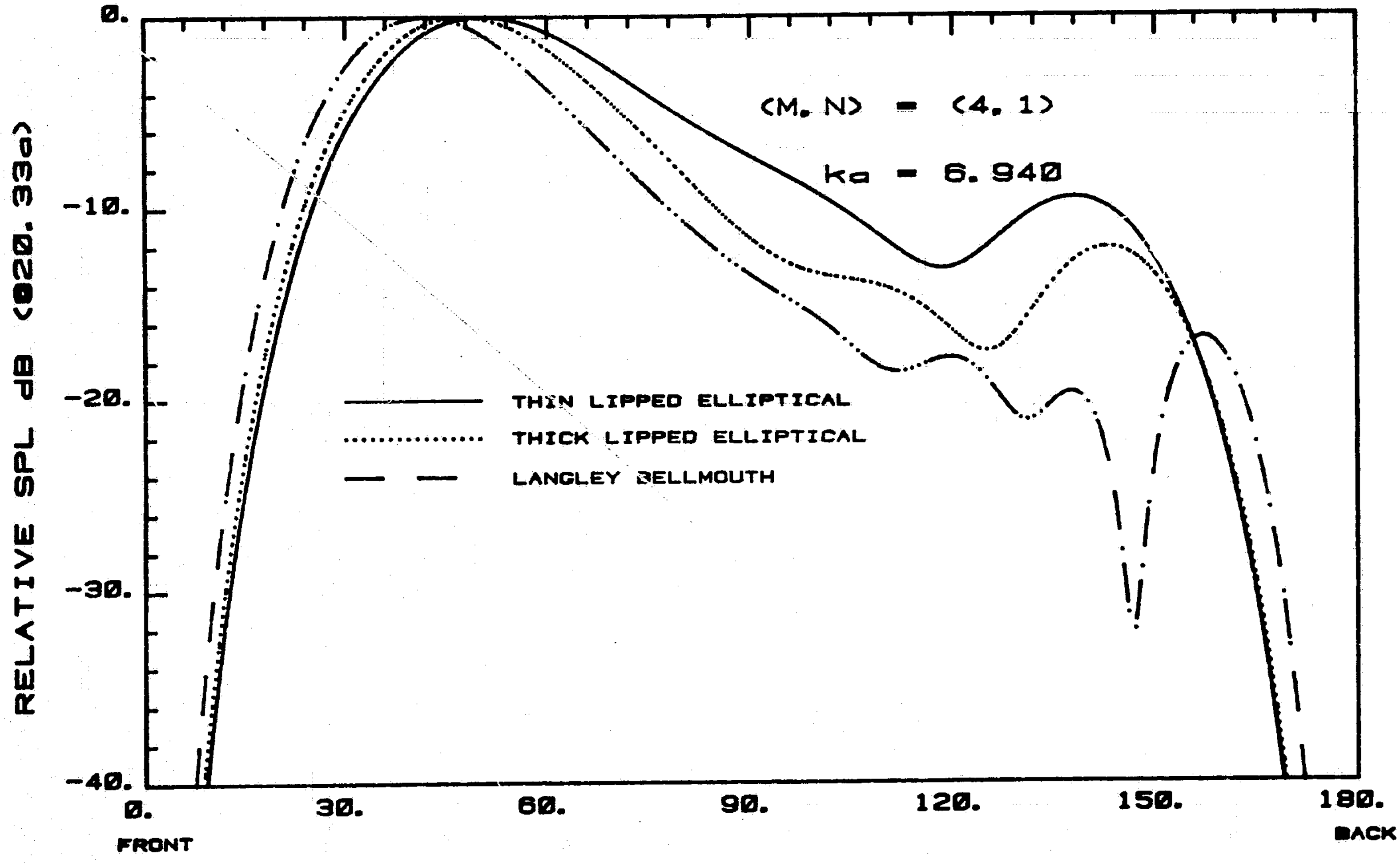


Fig. 61 g



CUT-OFF RATIO = 1.155

Fig. 61h



CUT-OFF RATIO = 1.305

Fig.61 i

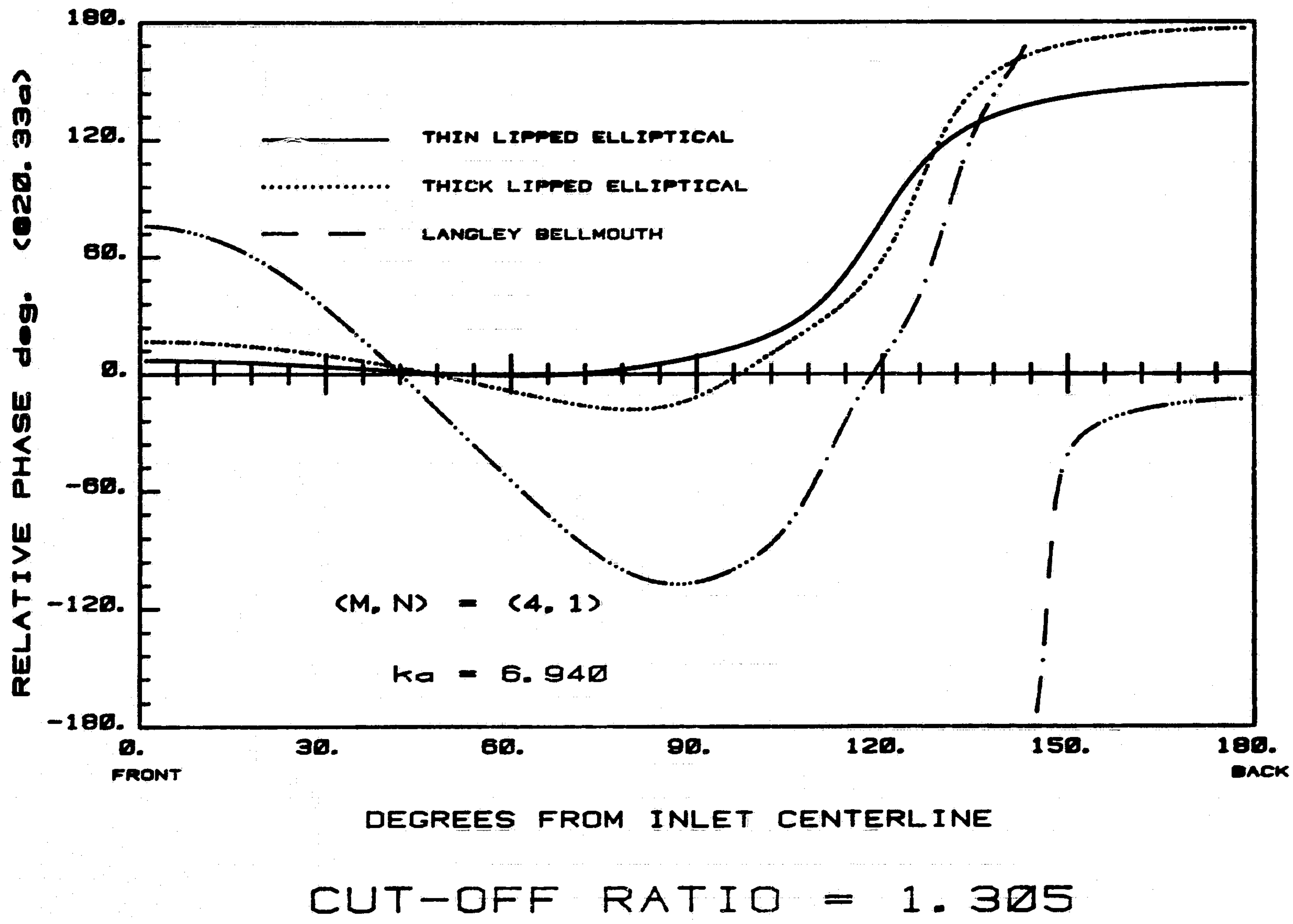

180.
120.
60.
0.
-60.
-120.
-180.
RELATIVE PHASE deg. (020. 33a)
THIN LIPPED ELLIPTICAL
THICK LIPPED ELLIPTICAL
LANGLEY BELLMOUTH
(M, N) = (4, 1)
ka = 6.940
0.
FRONT
30.
60.
90.
120.
150.
180.
BACK
DEGREES FROM INLET CENTERLINE
CUT-OFF RATIO = 1.305

Fig. 61j

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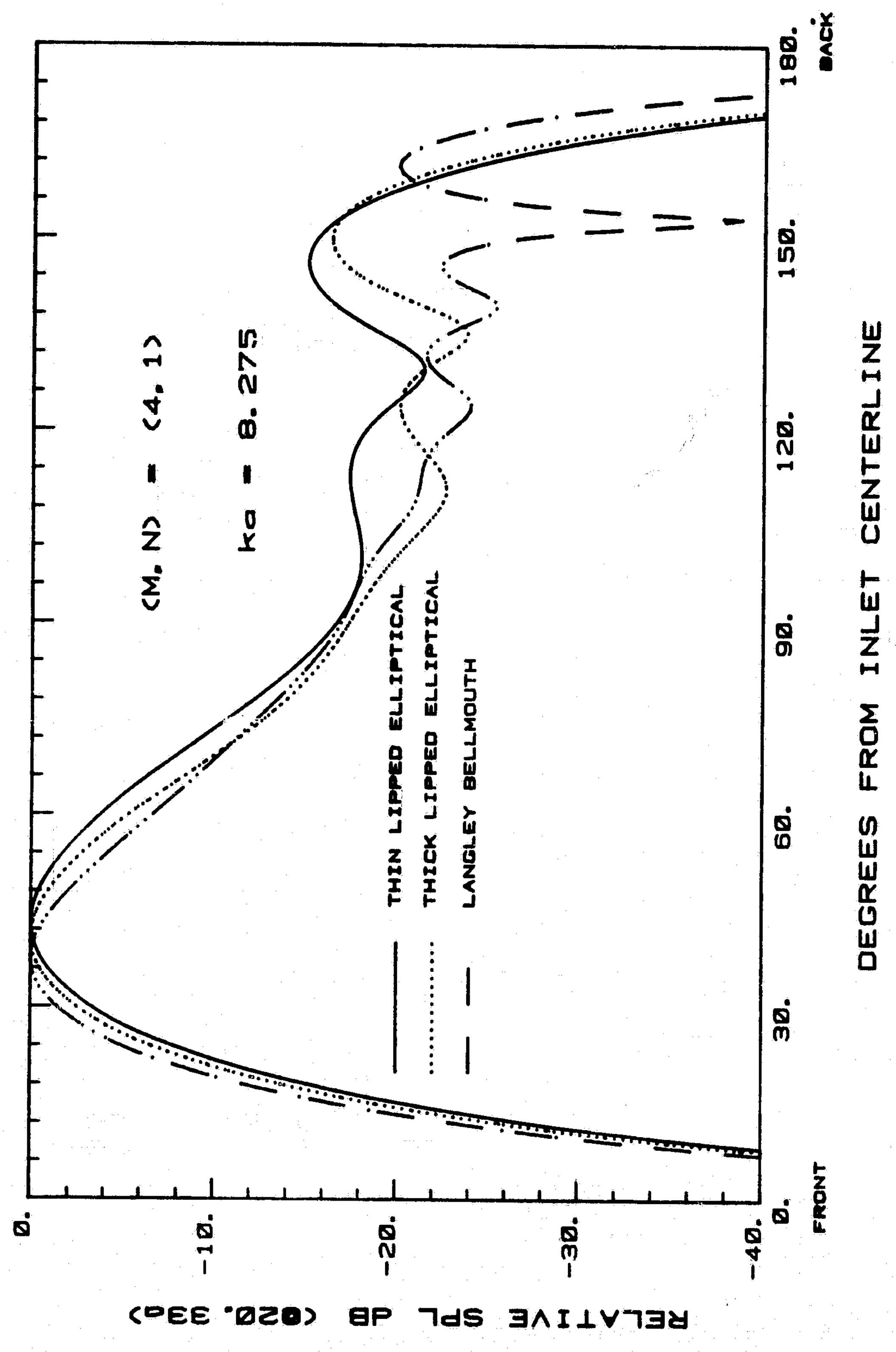
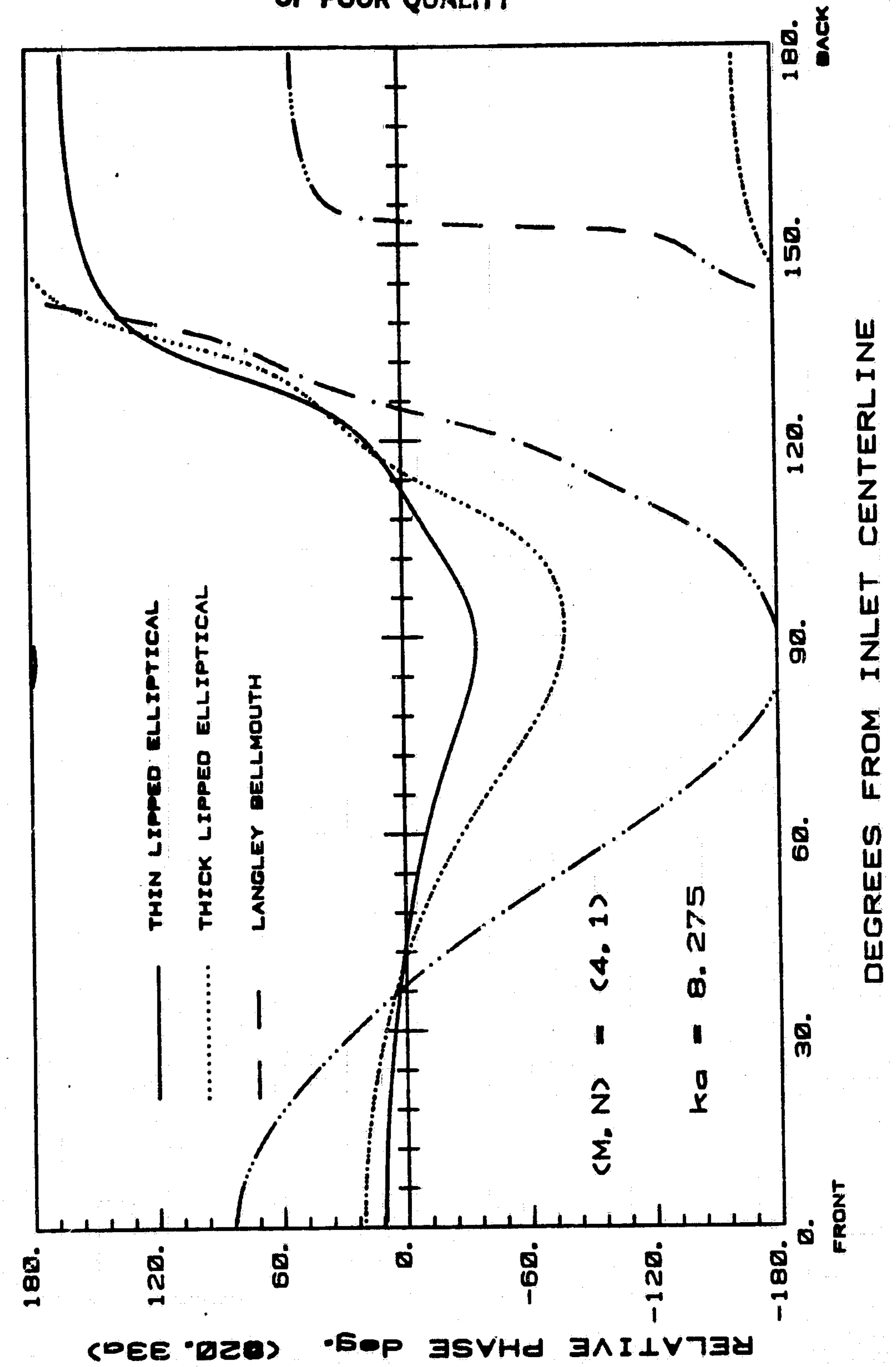


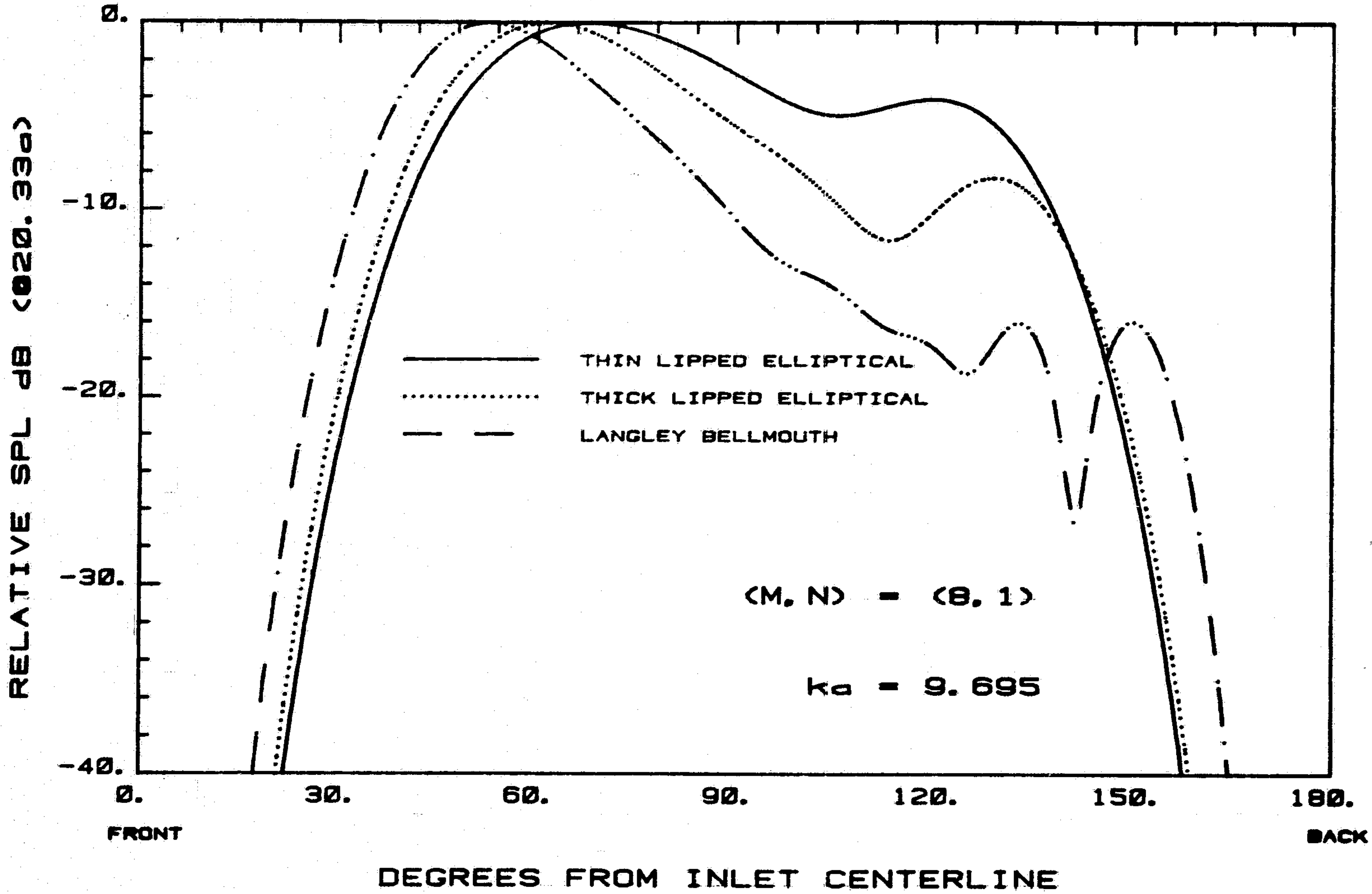
CUT-OFF RATIO = 1.556

Fig. 61k



CUT-OFF RATIO = 1.556

Fig. 611



CUT-OFF RATIO = 1.ØØ5

Fig. 62a

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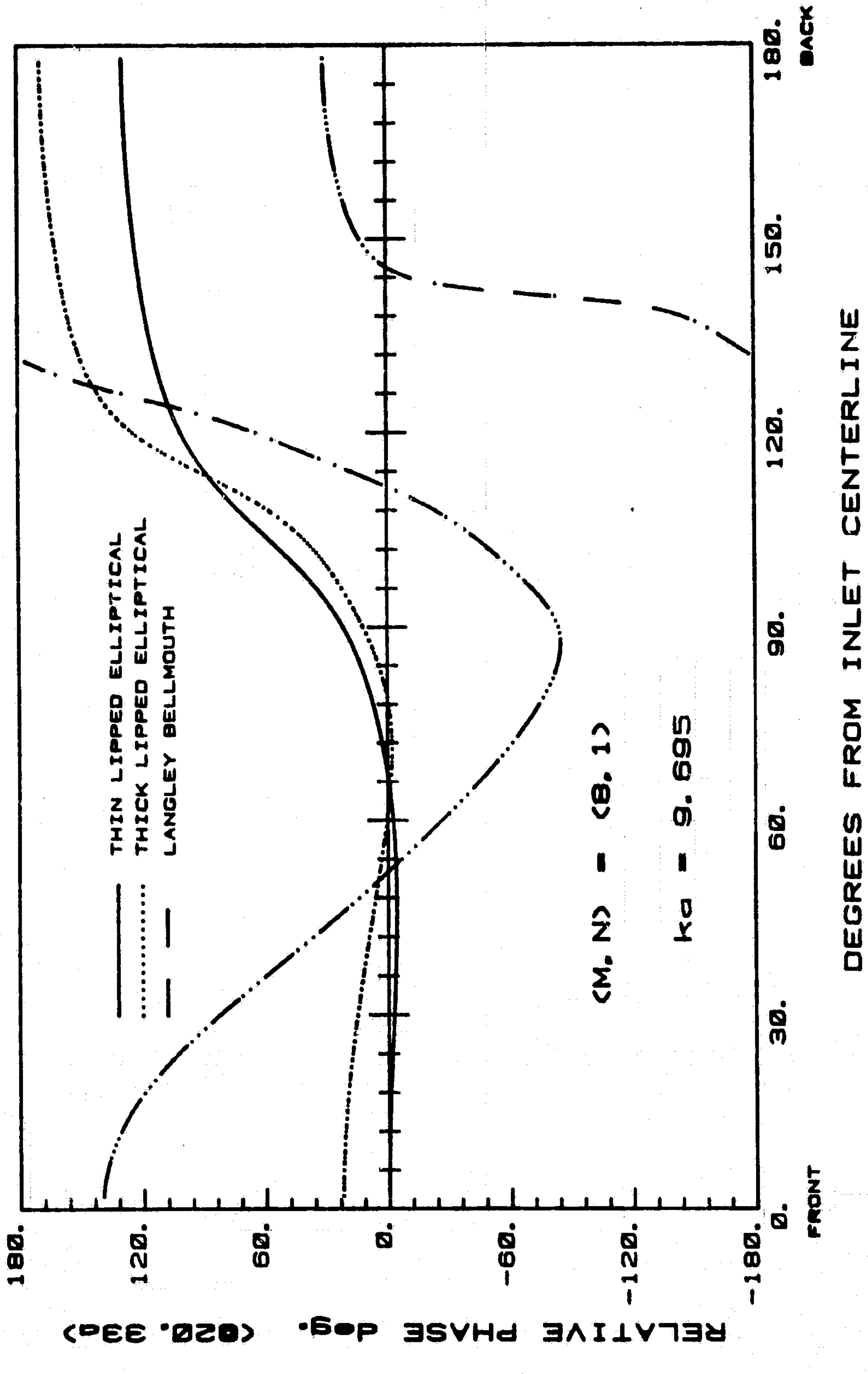

CUT-OFF RATIO = 1.005

Fig. 62b

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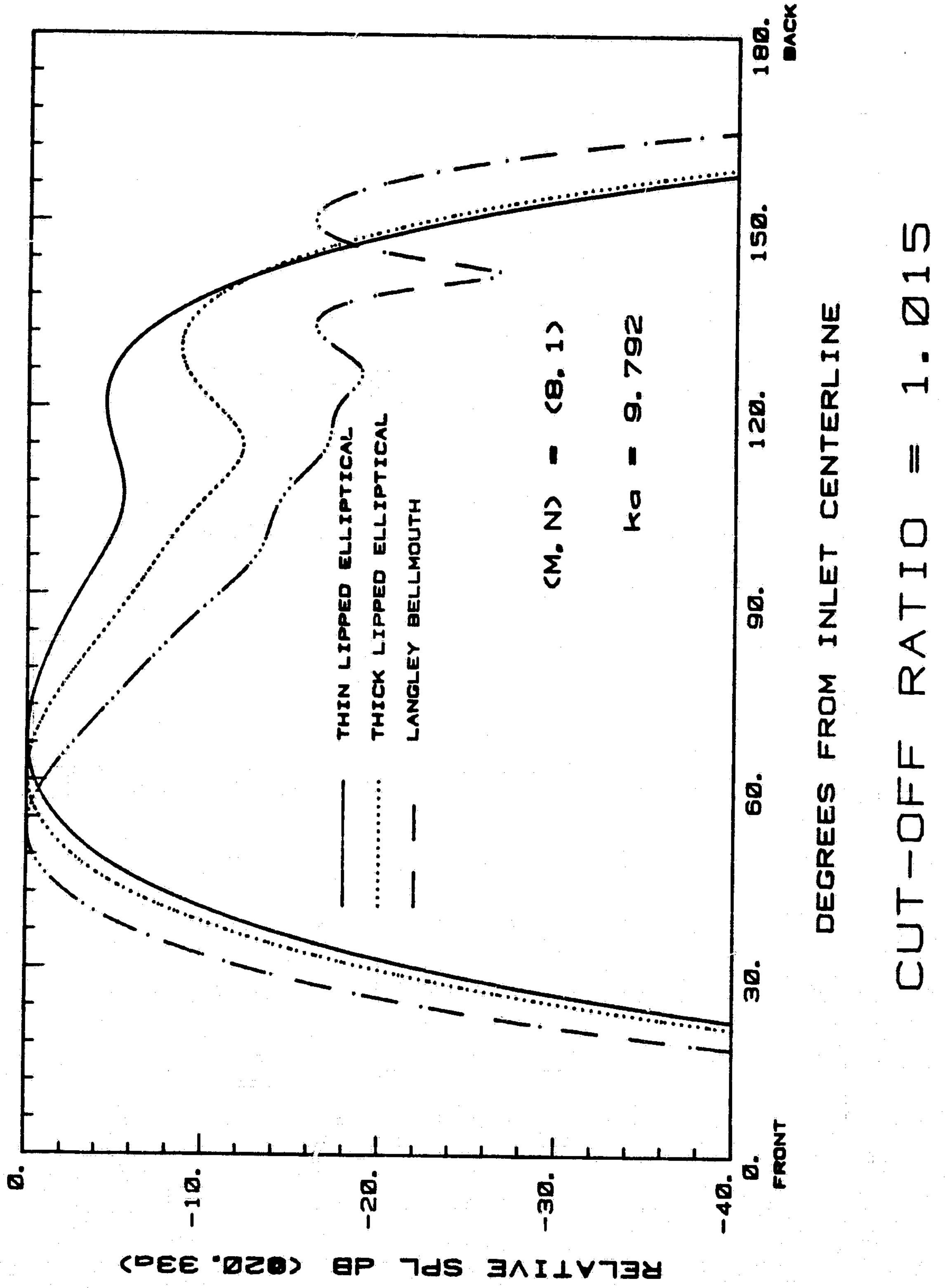
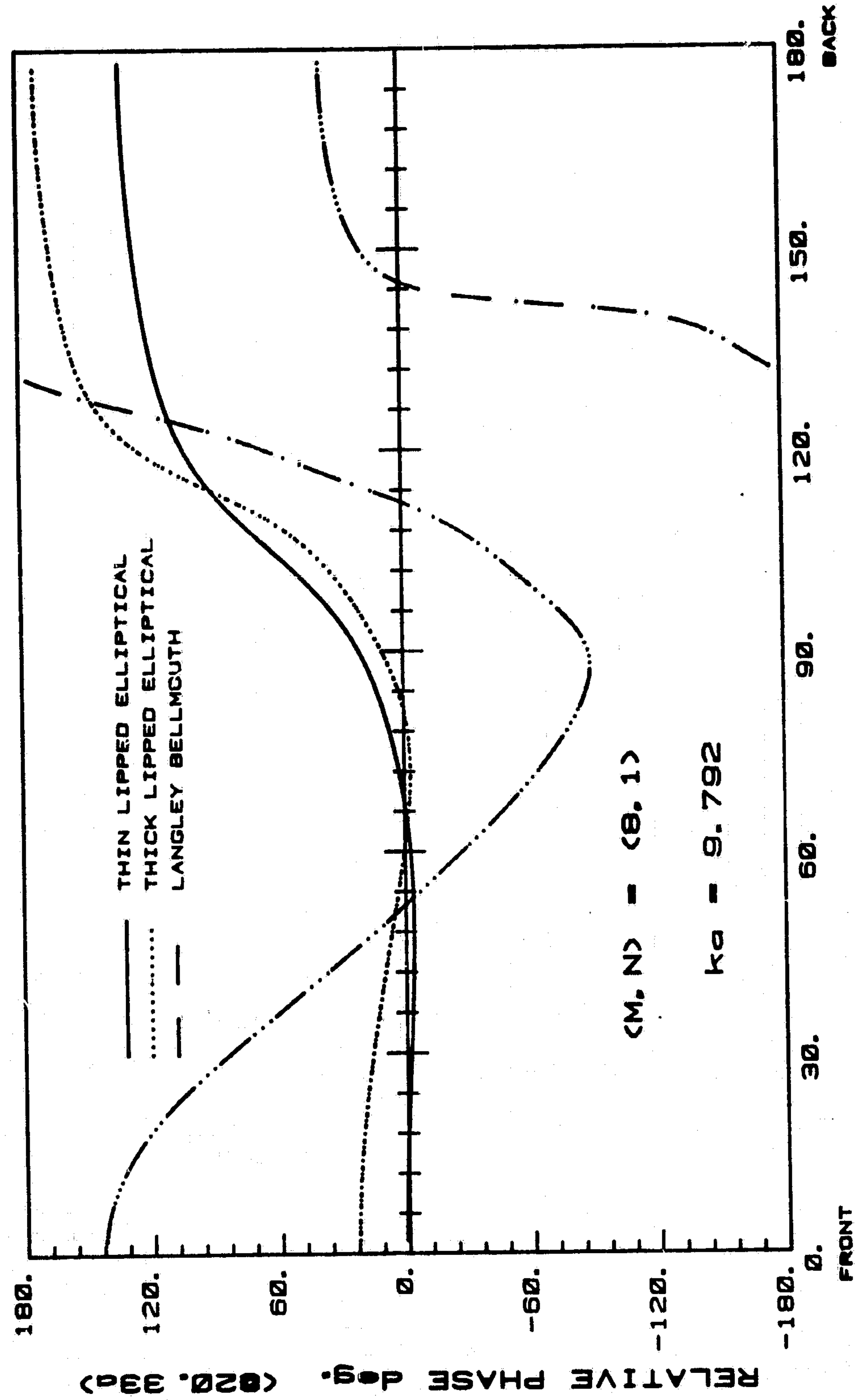


Fig. 62c



CUT-OFF RATIO = 1.015

Fig. 62d

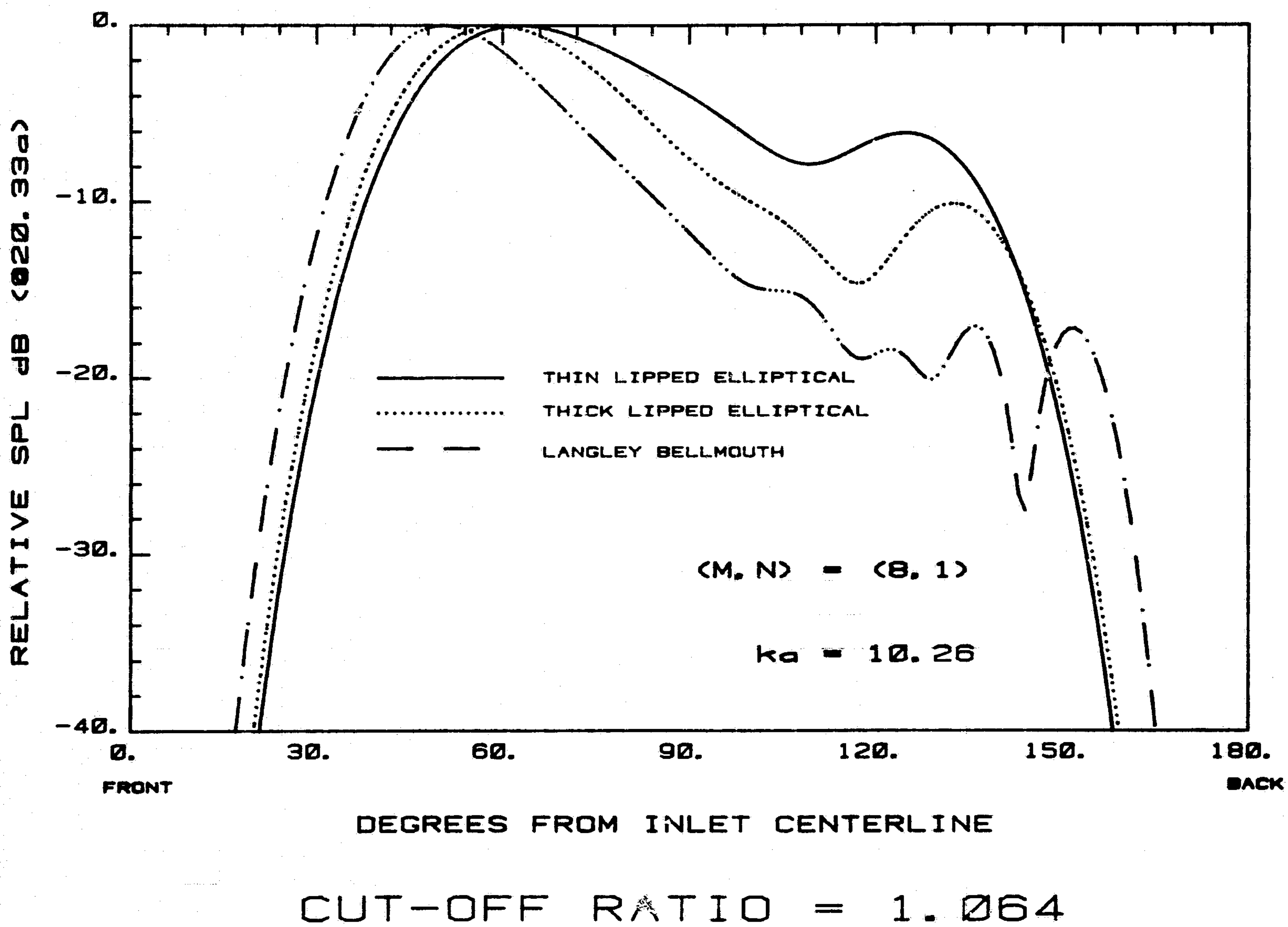

RELATIVE SPL dB (020. 33a)
0.
-10.
-20.
-30.
-40.
0.
30.
60.
90.
120.
150.
180.
FRONT
BACK
DEGREES FROM INLET CENTERLINE
THIN LIPPED ELLIPTICAL
THICK LIPPED ELLIPTICAL
LANGLEY BELLMOUTH
(M, N) = (8, 1)
ka = 10.26
CUT-OFF RATIO = 1.064

Fig. 62e

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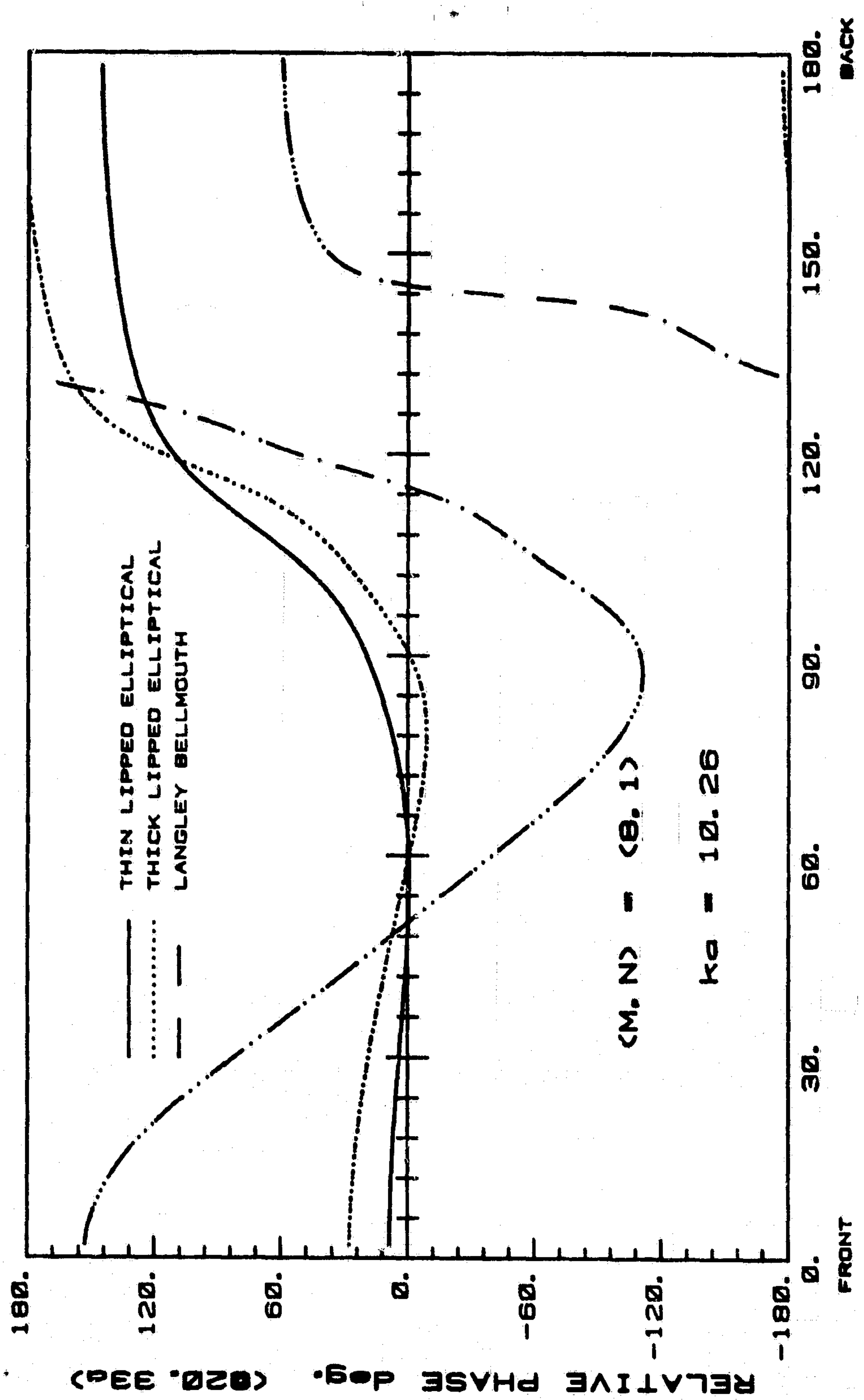

CUT-OFF RATIO = 1.064

Fig. 62f

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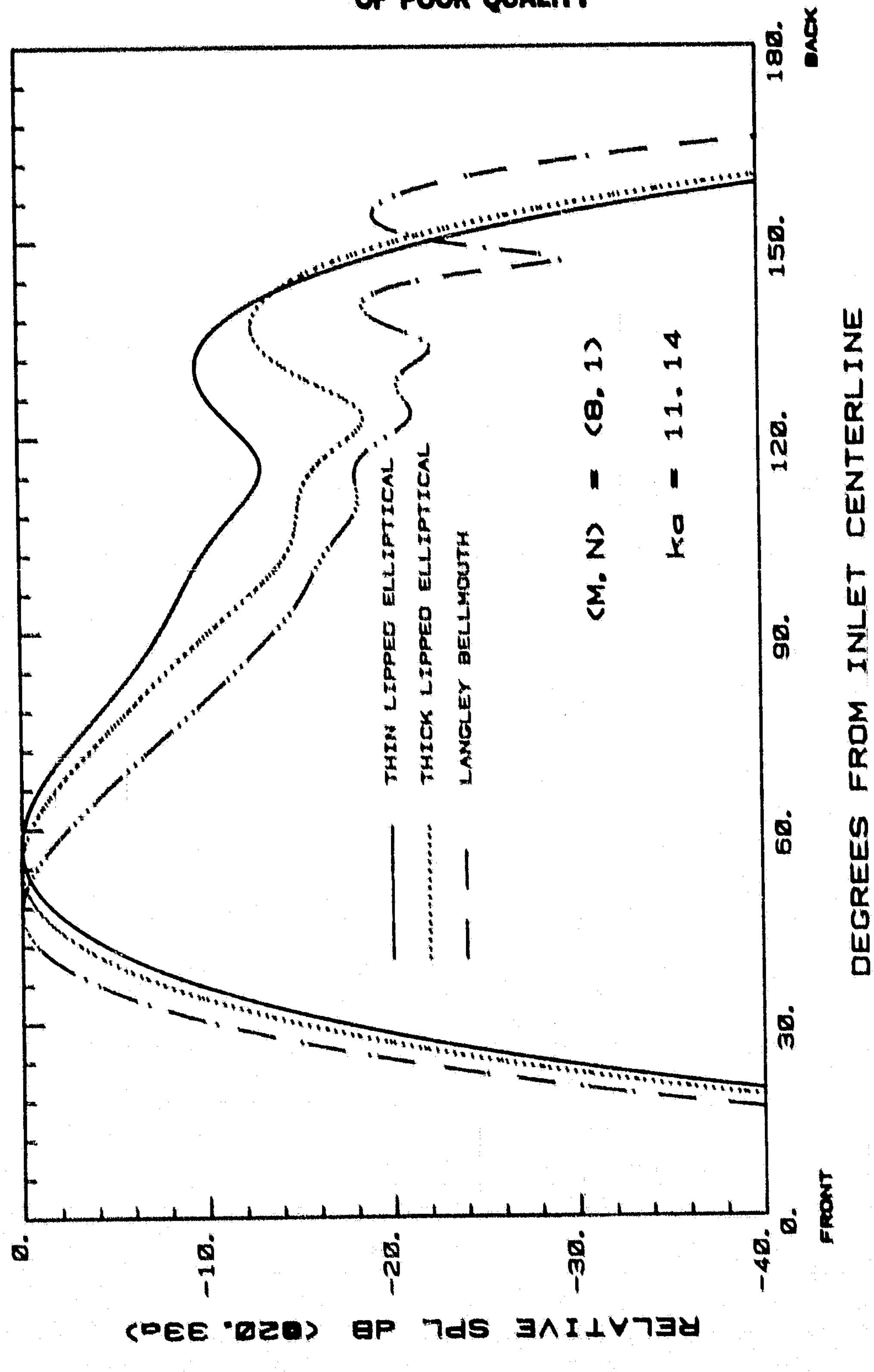
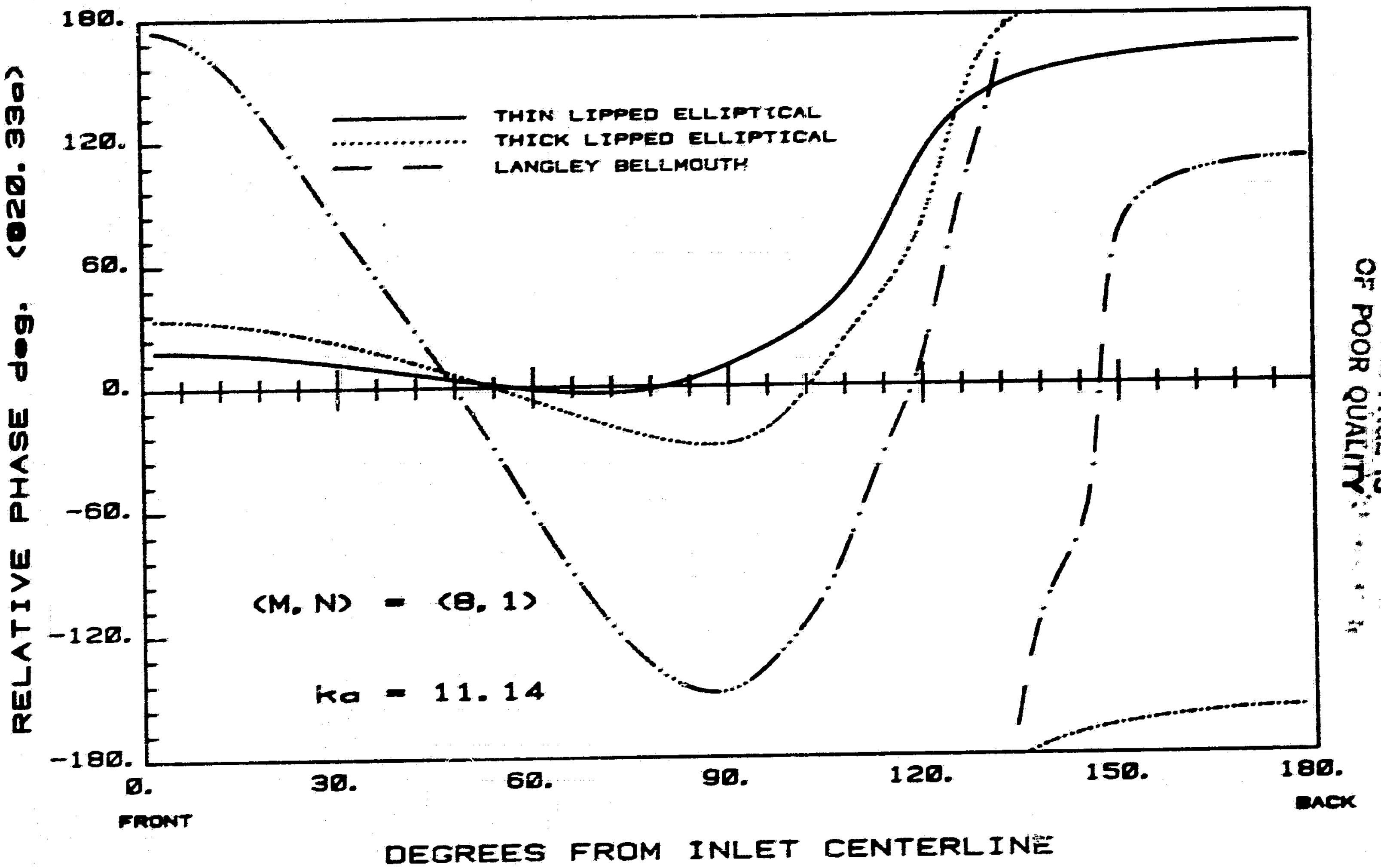


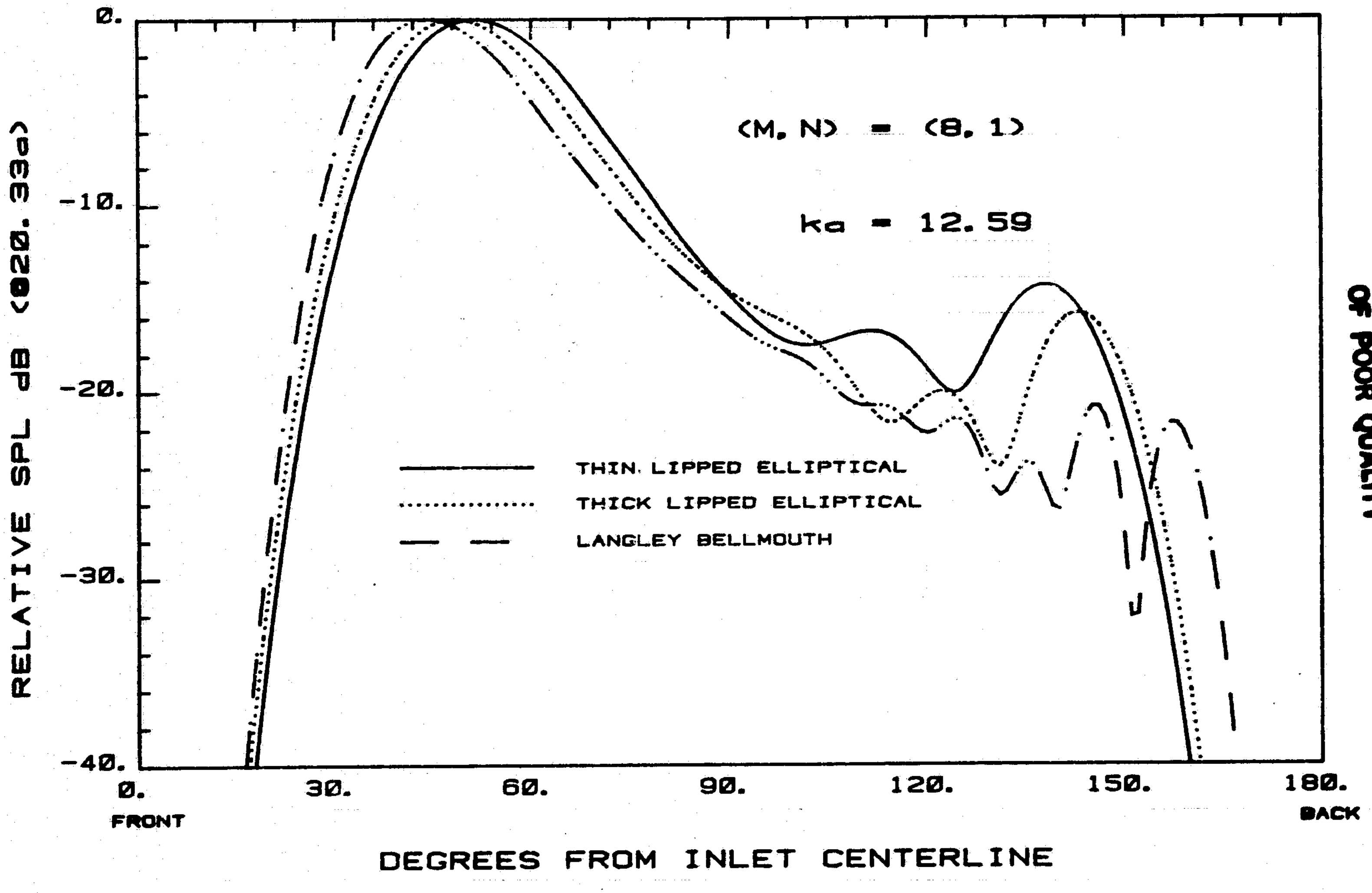
CUT-OFF RATIO = 1.155

Fig. 62g



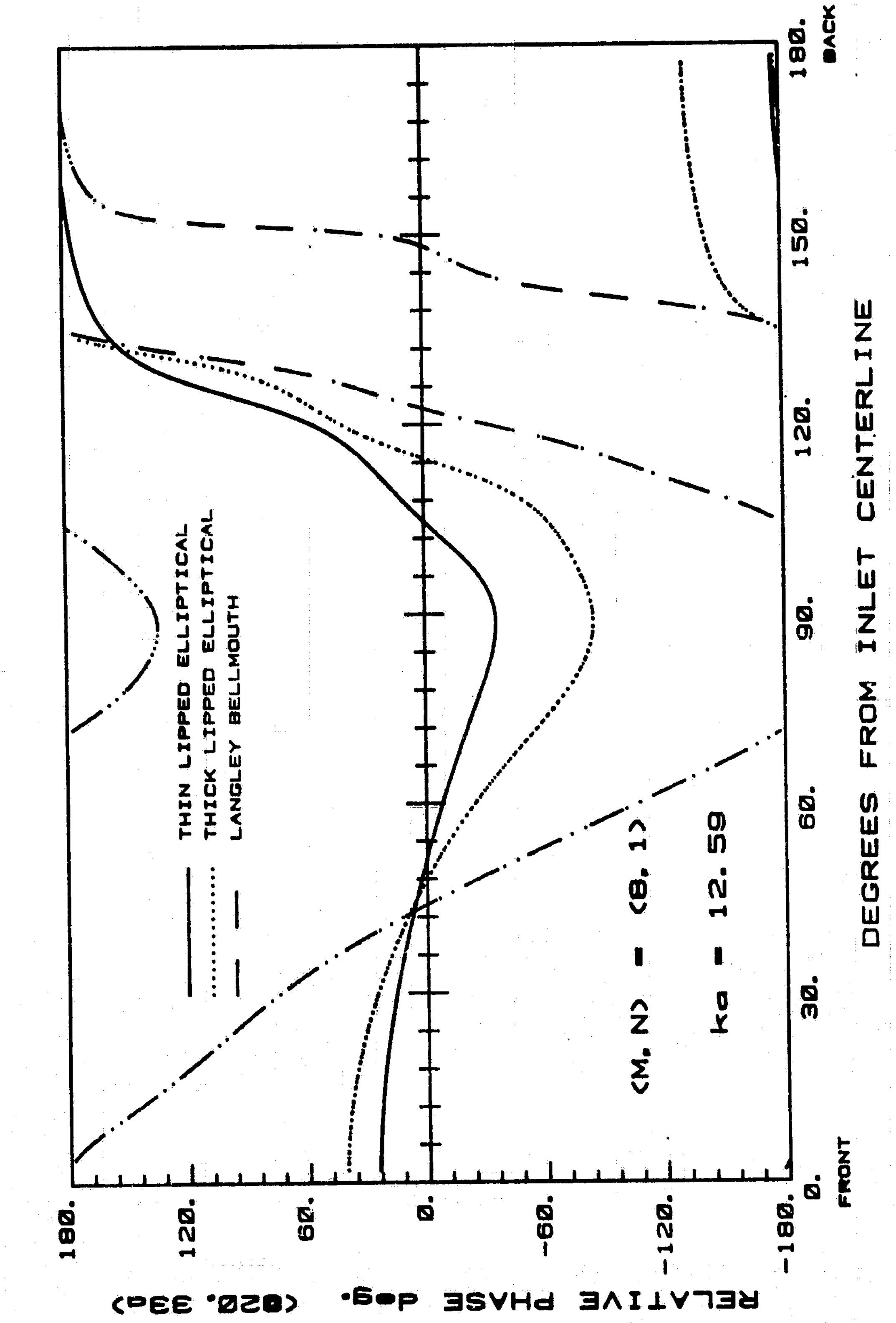
CUT-OFF RATIO = 1.155

Fig. 62h



CUT-OFF RATIO = 1.305

Fig. 62i



CUT-OFF RATIO = 1.305

Fig. 62j

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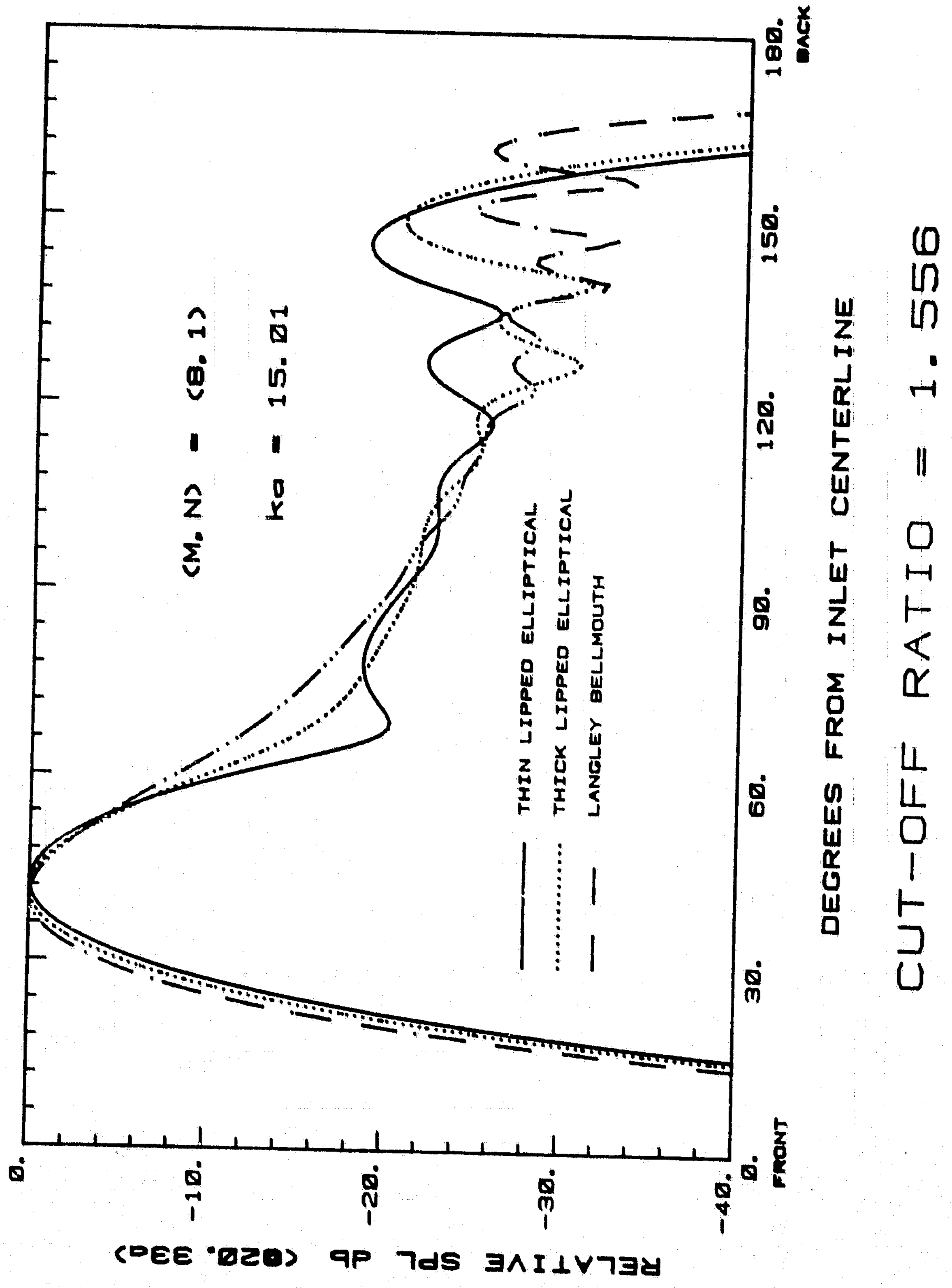
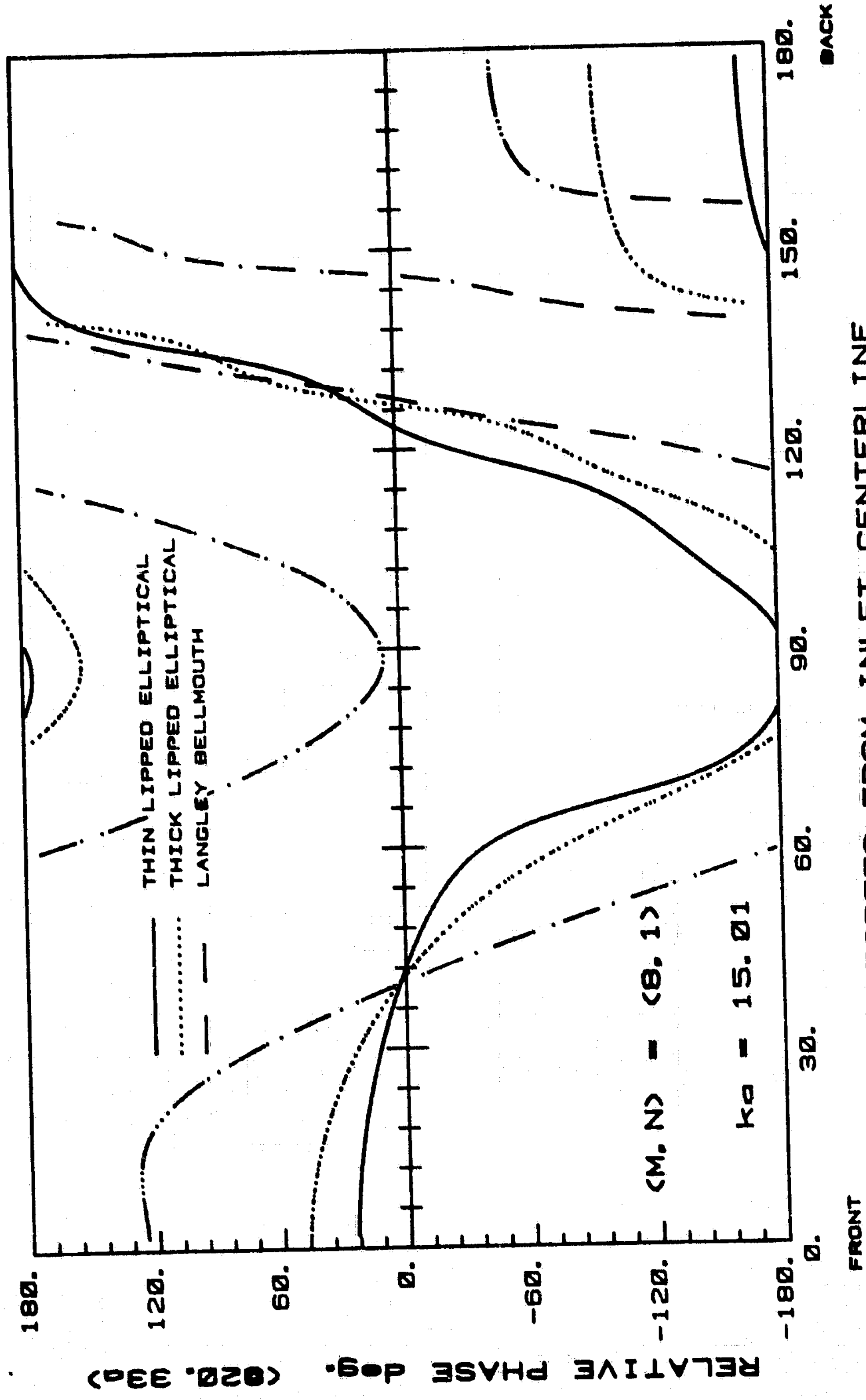


Fig. 62k



CUT-OFF RATIO = 1.556

Fig. 621

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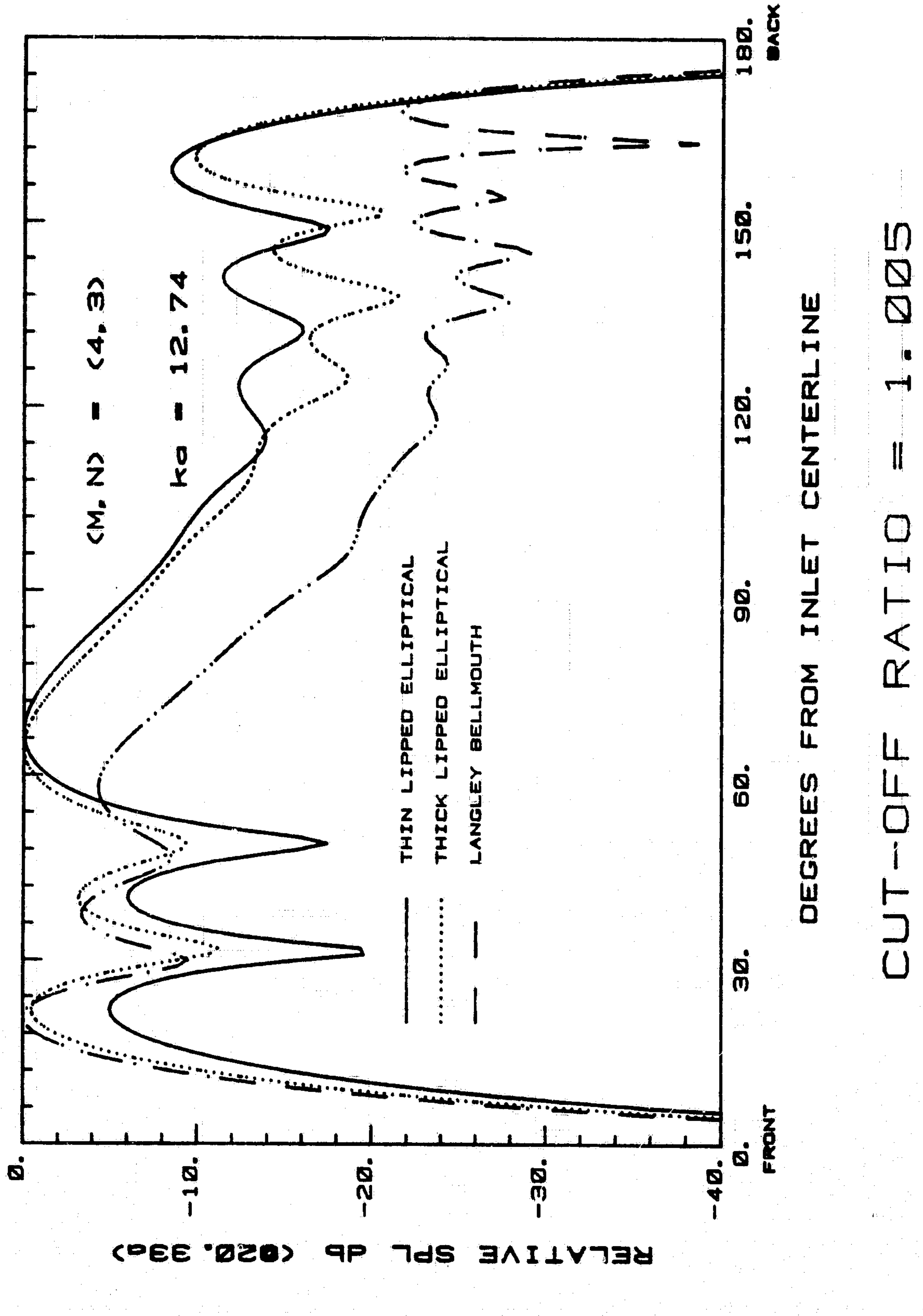

Fig. 63a

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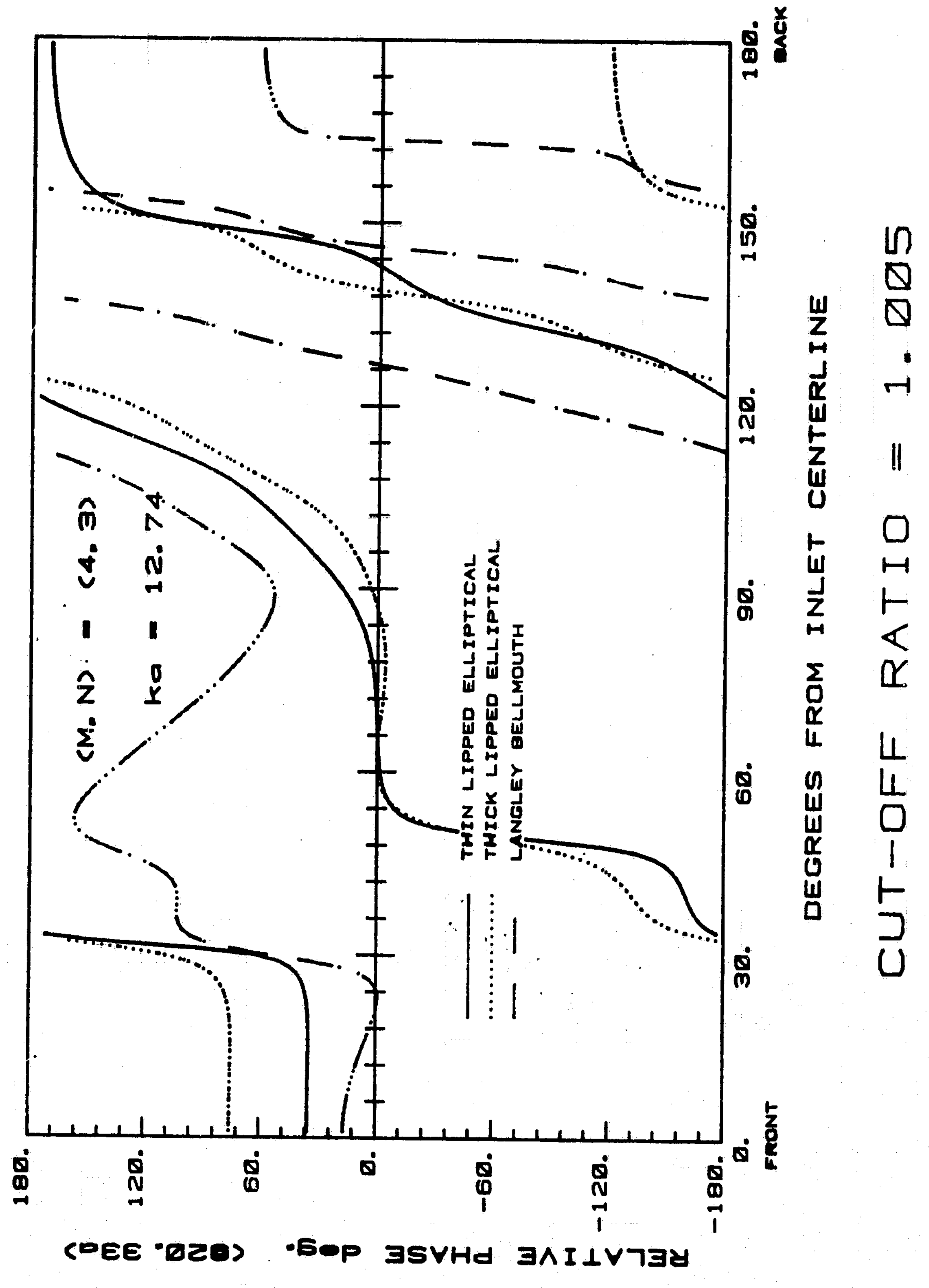

Fig. 63b

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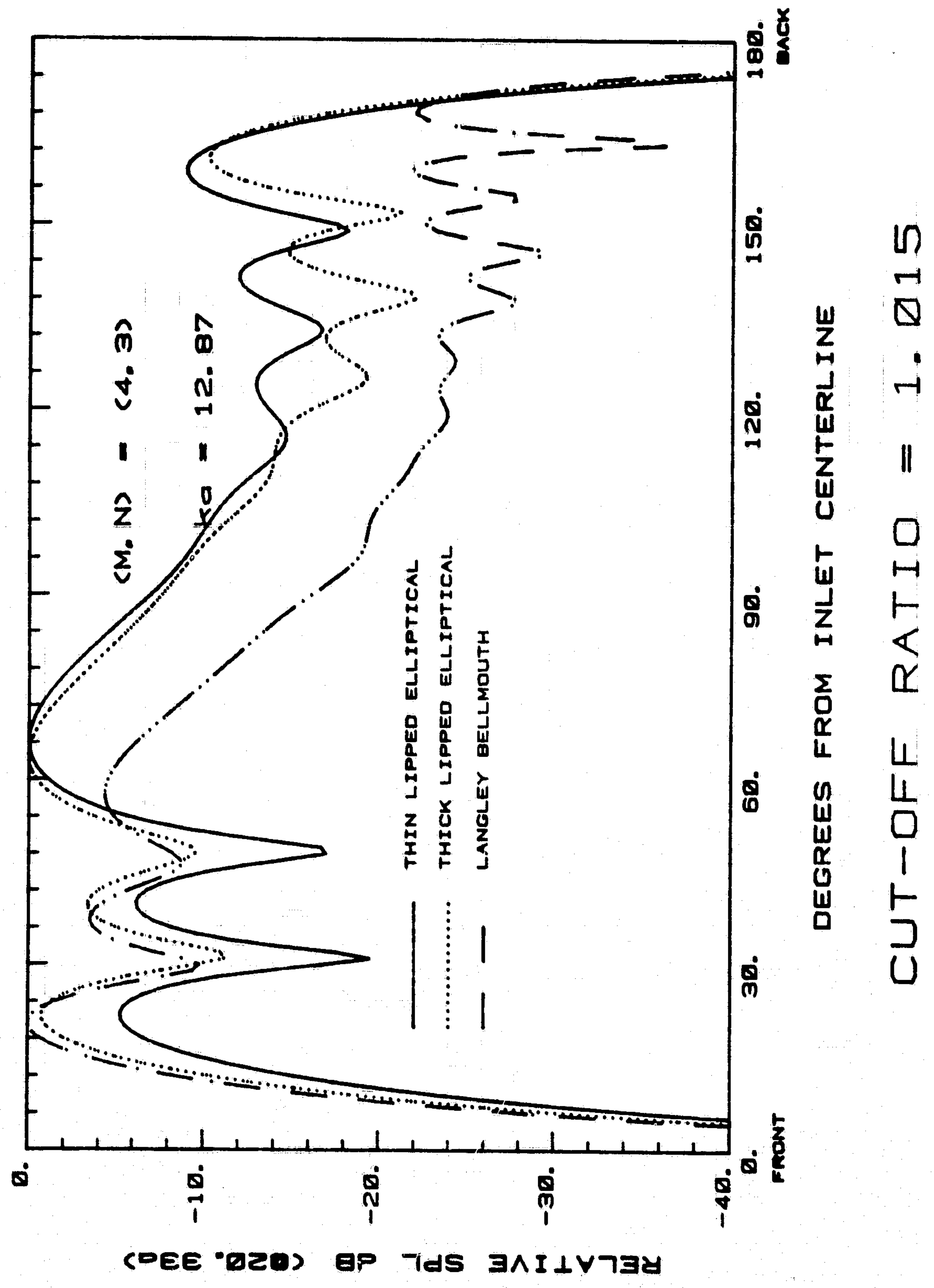

Fig. 63c

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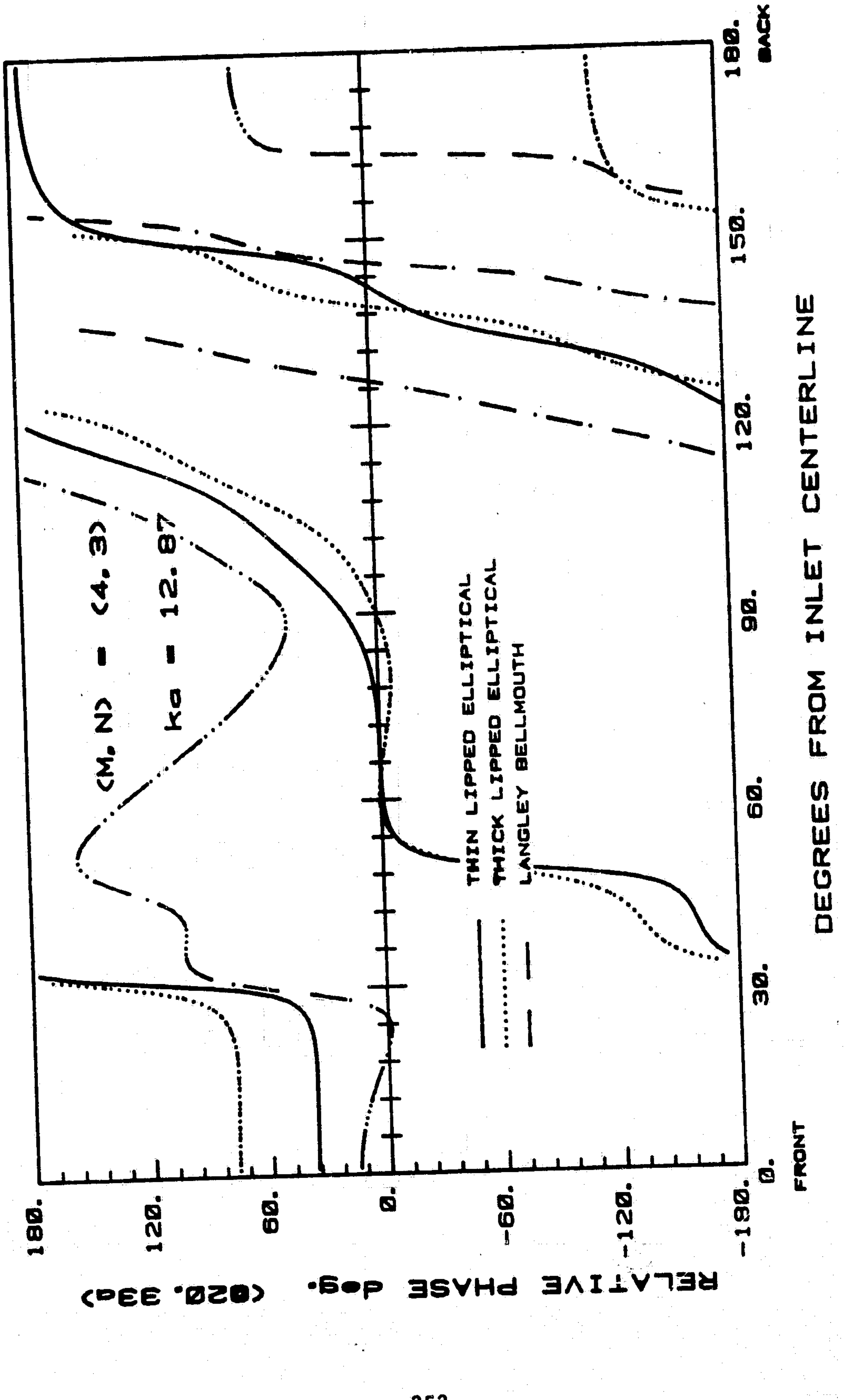

CUT-OFF RATIO = 1.015

Fig. 63d

ORIGINAL PAGE IS
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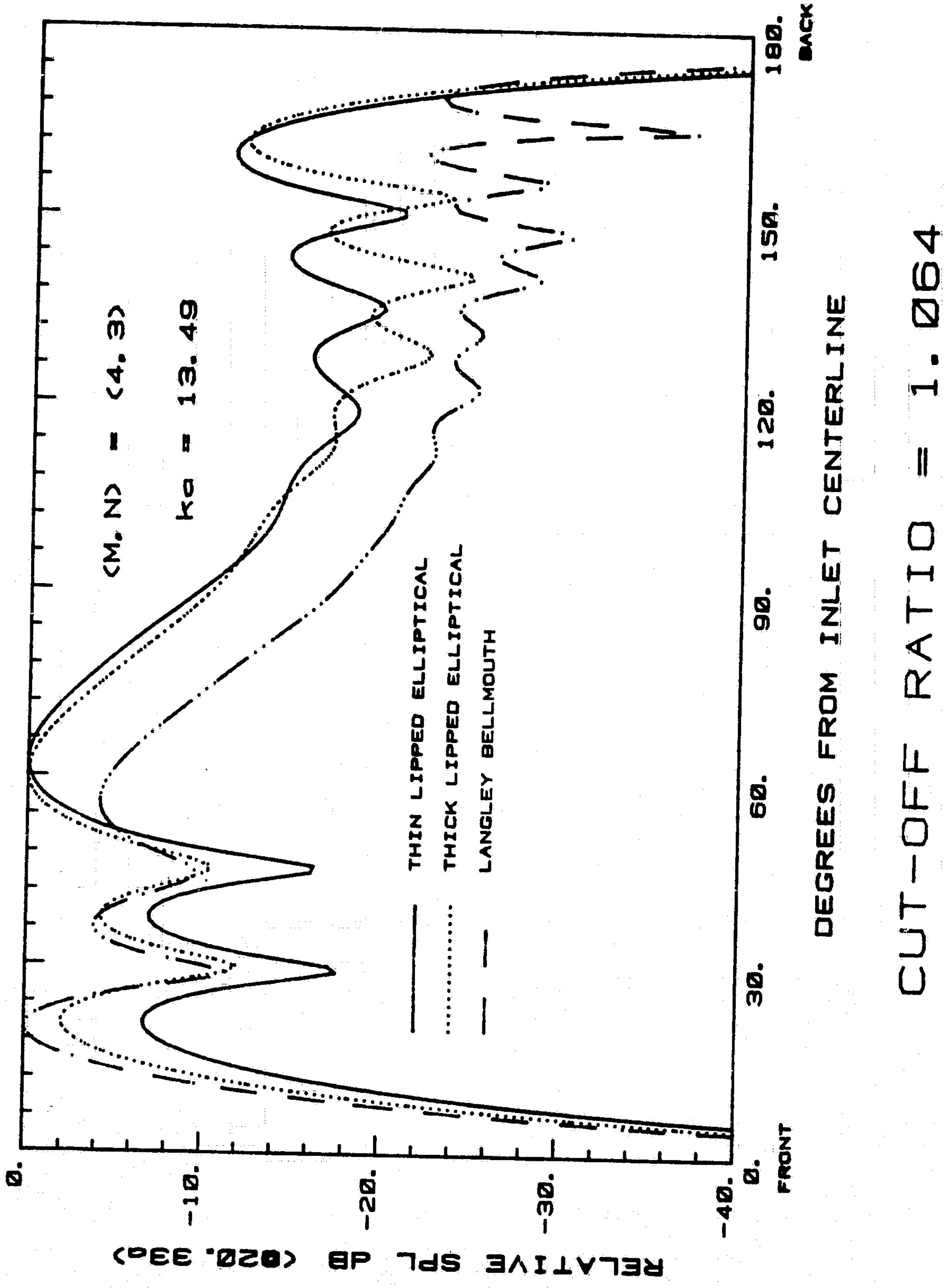

Fig. 63e

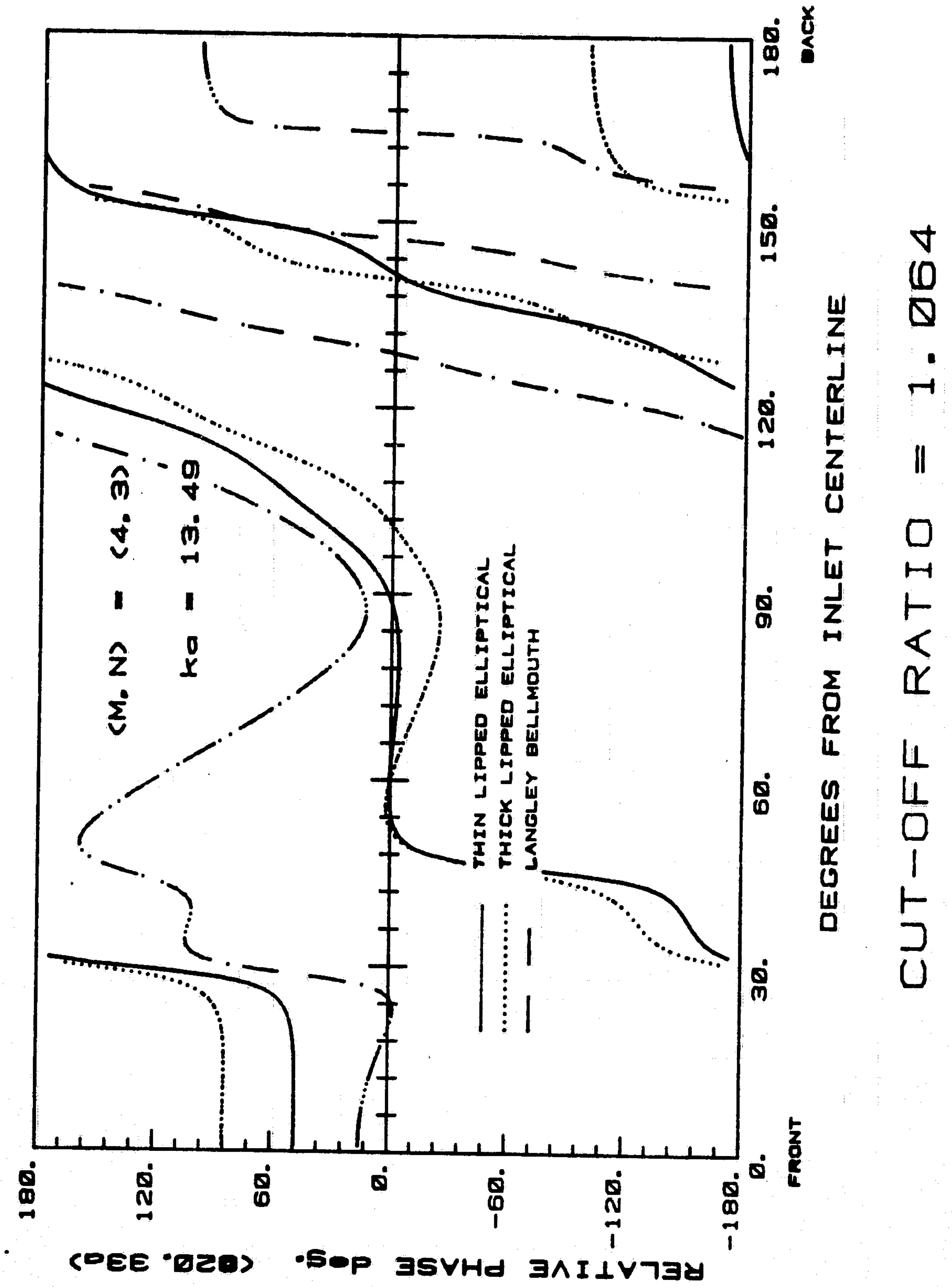
(M, N) = (4, 3)
ka = 13.49
THIN LIPPED ELLIPTICAL
THICK LIPPED ELLIPTICAL
LANGLEY BELLMOUTH
RELATIVE PHASE deg. (020, 33d)
180.
120.
60.
0.
-60.
-120.
-180.
0.
30.
60.
90.
120.
150.
180.
FRONT
BACK
DEGREES FROM INLET CENTERLINE
CUT-OFF RATIO = 1.064

Fig. 63f

ORIGINAL PAGE IS
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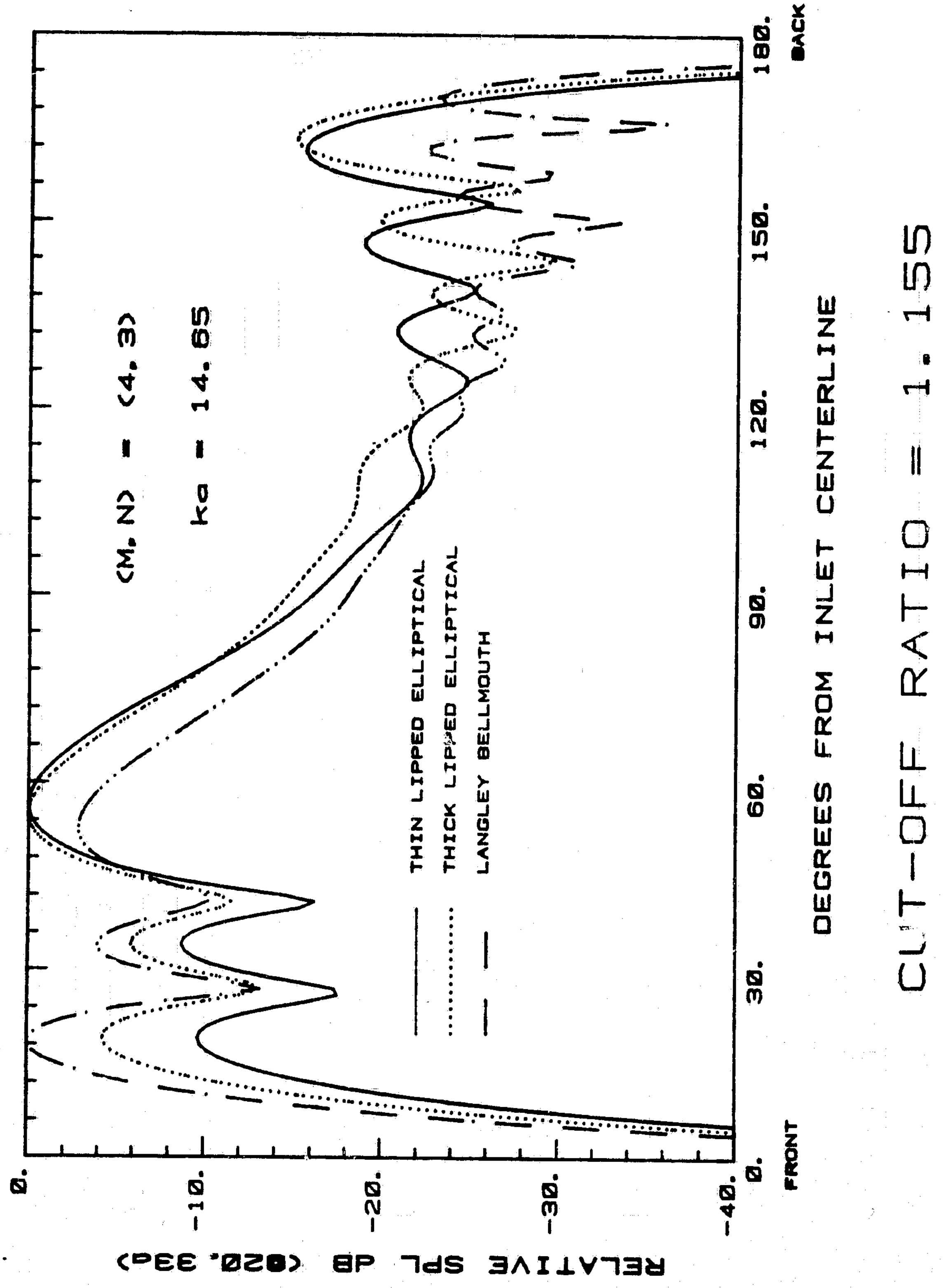
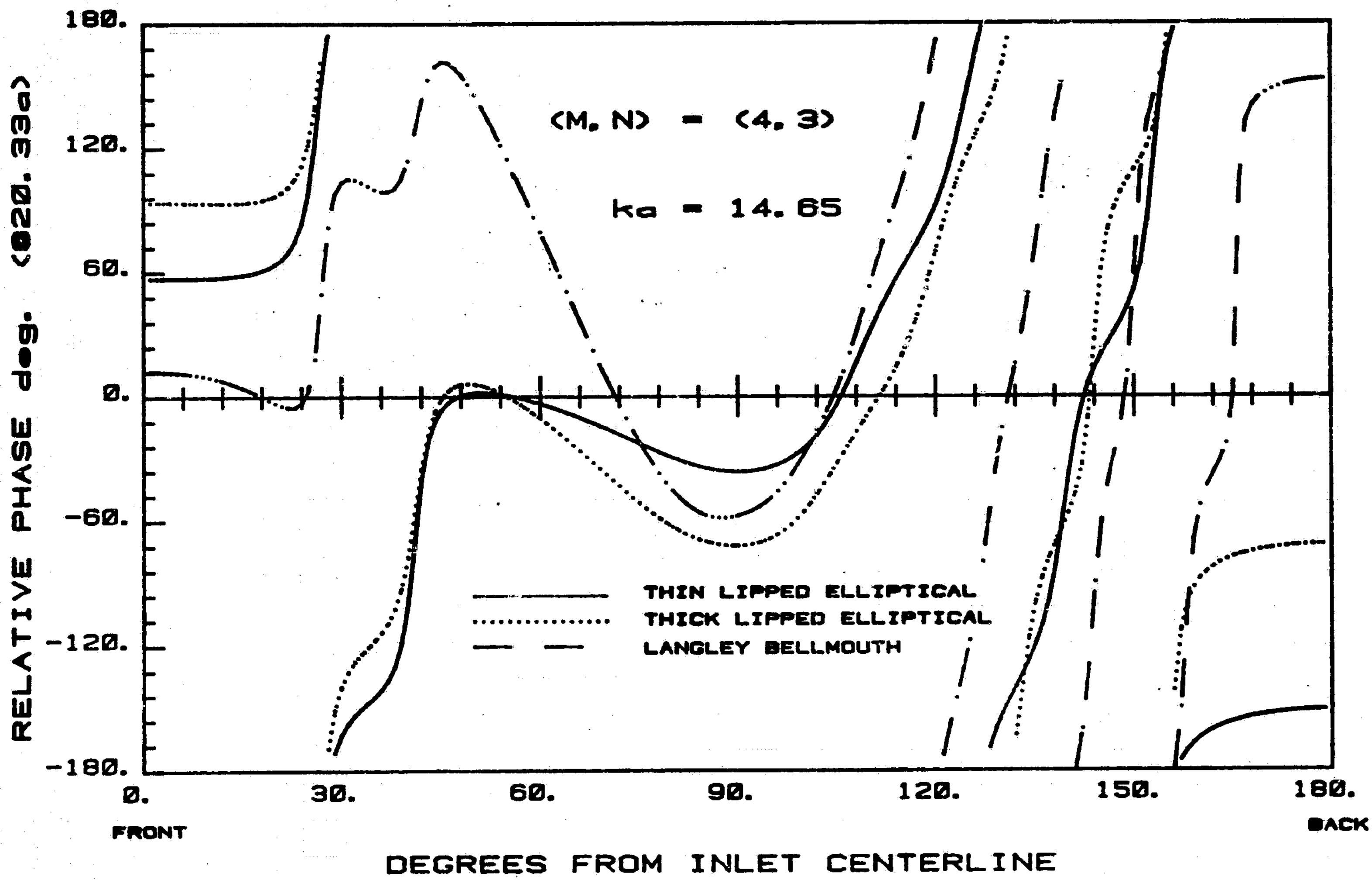
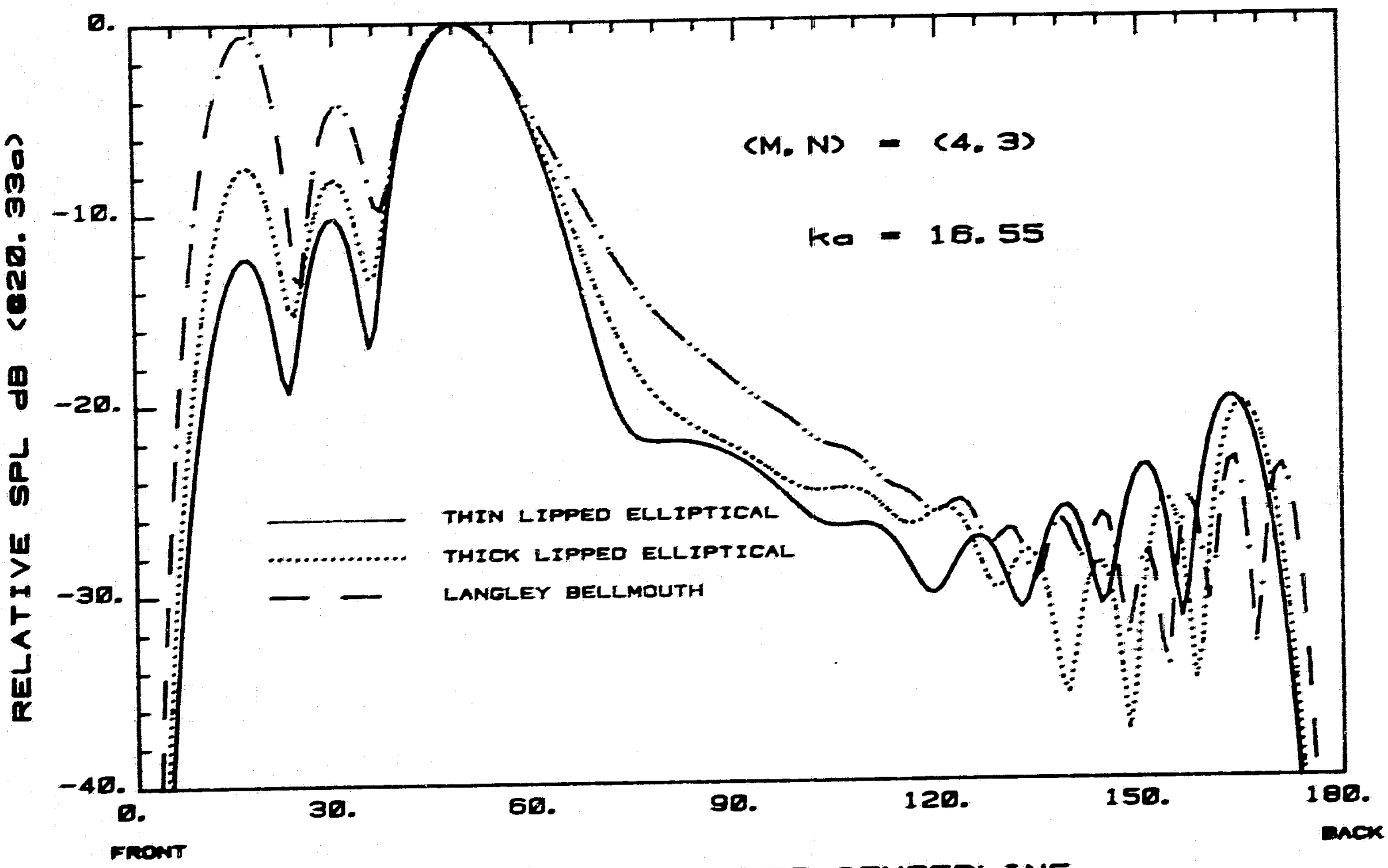


Fig. 63g



CUT-OFF RATIO = 1.155

Fig. 63h



CUT-OFF RATIO = 1. 305

Fig. 63i

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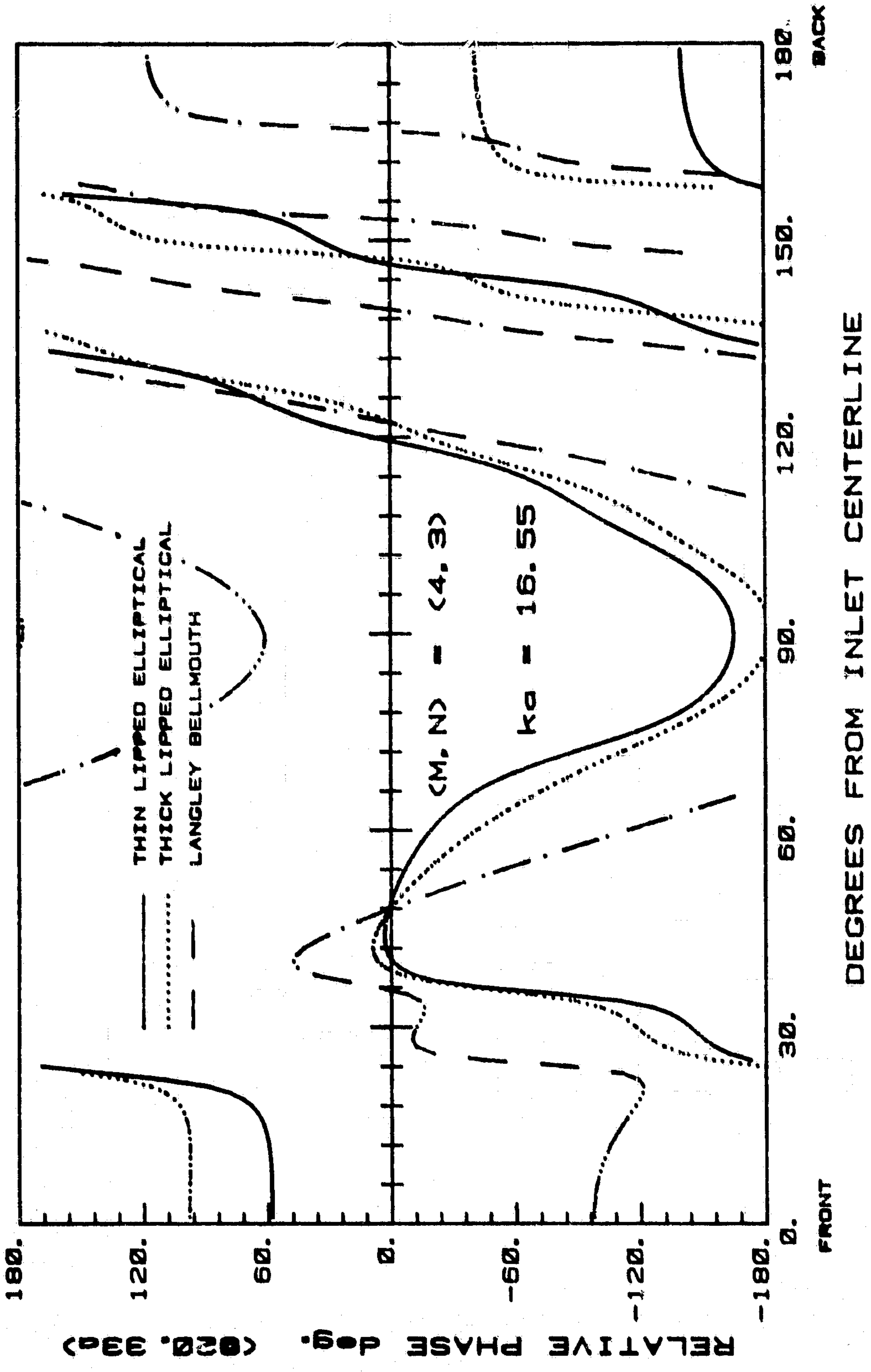

CUT-OFF RATIO = 1.305

Fig. 63j

ORIGINAL PAGE IS
OF POOR QUALITY

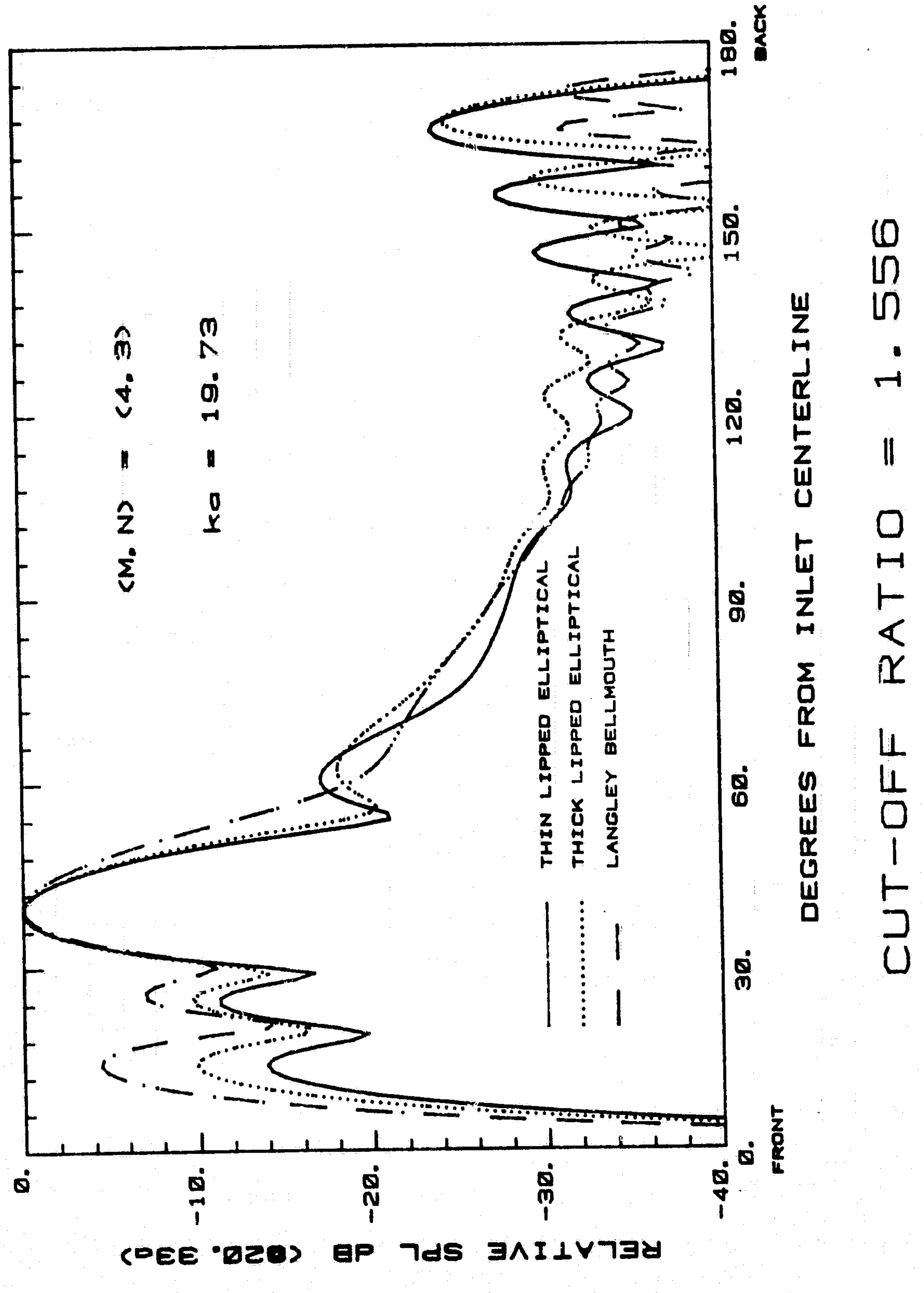

Fig. 63k

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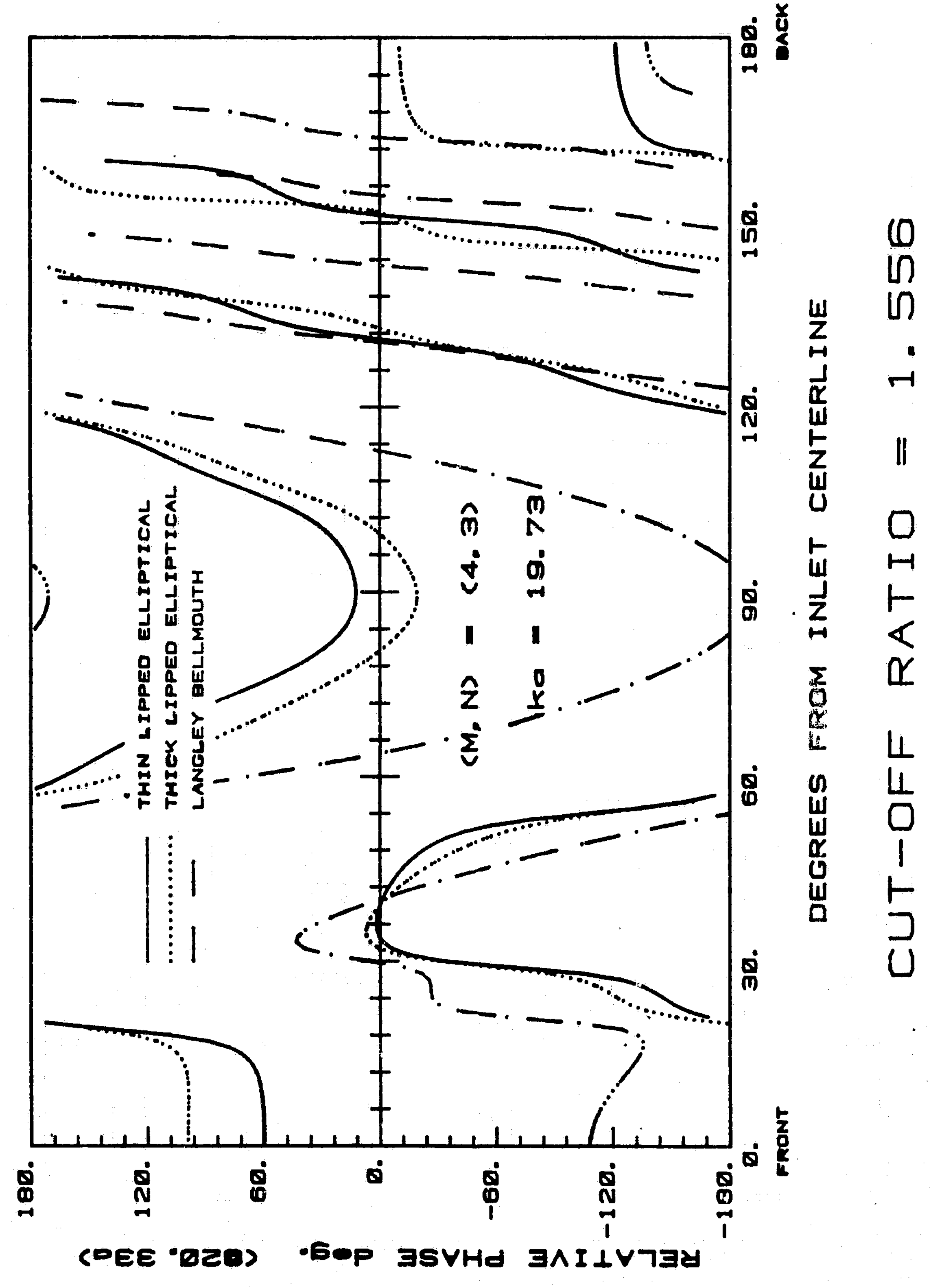

Fig. 631